MINISTRY OF AGRICULTURE, COMMERCE AND INDUSTRIES
DIRECTION OF INDUSTRIES.
NATIONAL SECTION OF MINING AND GEOLOGY.

OFFICIAL REPORT

UPON

THE MINES, MINING, METALLURGY AND MINING LAWS, &c., &c.

OF THE

ARGENTINE REPUBLIC.

BY

H. D. HOSKOLD

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PREFACE

In 1887, the author was honoured and commissioned by the National Government, to write an original work upon the Mining and Metallurgical Industries and allied subjects of this Republic, in the Spanish and French languages, to be illustrated with Maps, Plans and Sections. Those works were comprehensive, and extensively distributed at the Universal Exhibition of Paris, in 1889: as, also, throughout the principal cities of Europe, the British colonies, North and South America; and, at the Chicago Exhibition, in 1893, they were examined by the International Jury of technical literature, who accorded the highest award.

Considering that no authorized official work upon the subjects named above has appeared within a quarter of a century, in the English language, the writer has been again honoured with a commission from His Excellency, the Minister of Agriculture, Commerce and Industry, Doctor Wenceslao Escalante, and by the President of the Argentine Directive Commission of the San Louis Exhibition, (United States of North America) 1904, to write a new work upon the Mining and Metallurgical Industries, etc., of the Country, in the English language, ostensibly for distribution in the Exhibition indicated. Also to make

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and classify a characteristic collection of minerals, sufficient to represent the country in a dignified manner.

Considering that the author received his instructions rather late, he regrets that the time at his disposal to complete the work indicated was much too limited and, consequently, he found it impossible to postpone its completion until all the requested data came in.

Naturally, therefore, it may be inferred that consequent upon the too hurried manner in which the work was obliged to be written that defects and omissions exist in it.

However, it is proposed to produce a second edition, at an early date, and it will then be possible to eliminate imperfections and to present it in an extended form.

H. D. HOSKOLD.

Buenos Aires, 30 April 1904.

CHAPTER I

Historical Notice Upon The Ancient Mines And Mining in the Argentine Republic, etc.

With a view of rendering this introductory chapter as interesting as possible, and as a Standard of reference upon the subjects introduced in it, all accessible sources of information, traditional and otherwise, in any way bearing upon the ancient mines and mining in this Republic, have, it is believed, been exhausted.

In order to give to it a more general, or broader scope, it has been considered necessary to note at some length connected historical events referring to other parts of South America.

In this way, it has been sought to raise from obscurity various points of National interest which may be considered to benefit the present and future generations, which otherwise may have been forgotten and lost to the general public.

The historical records which have been handed down referring to the state of South America anterior, and at the time of the spanish conquest, were chiefly confined to official and private documents written during the Spanish campaign un-

dertaken against the aborigines, and immediately after the final victory. The former were comparatively few, and consisted chiefly of communications made to the court in Spain by military officials, and others residing in the country, while some of the latter were retained in the offices of the Spanish Authorities in America, and found their way into the hands of family descendants residing in Spain, and in America; but in the latter case many of these papers, which were of the greatest importance, were lost or otherwise destroyed during the troubled times of the Civil wars, which raged furiously for a protracted period in many parts of the Argentine Republic.

These circumstances, connected with the extraordinary neglect, and little interest possessed by some of the official authorities from the time of the conquest and for a considerable time afterwards, are among some of the principal reasons why the Provincial Argentine Archives are so scant in information of every kind; there is, therefore, little more than tradition remaining to guide us in framing a judgement upon the occurrences forming the long history of the various aboriginal tribes then inhabiting this part of South America, and if we were to analyse the numerous transmitted accounts, we should find that they are so vague, conflicting and uncertain in their character, that to attempt to unravel and deduce the truth by that medium, would entail a study hopelessly beset with insuperable difficulties.

A very great interest is, however, attached to this obscure, although important subject, which increases in intensity in proportion to the extent of the study devoted to it.

Doubtless it was this laudable spirit of enterprise which impelled Prescott to the irresistible desire to enquire into, unravel, and determine, as far as it was then possible, fhe circumstances connected more especially with the last of a long

line of potentates of Mexico and Peru; and as a result, present to us works so interesting, important, exhaustive, and graphically written, that it is vain to hope that they will ever be materially improved by the introduction of independent facts of importance, or indeed, that anything new will be brought to light, unless continued expeditions were to be undertaken in South American countries, especially in the Argentine Republic which is the principal part of this great Southern Continent, under the patronage, and at the cost of some liberal government.

The origin of the various Aborigines, or Indian tribes of South America, like their history, is very obscure, and as it appears has never been definitely determined, or indeed approximated; but it is reasonable to infer, that a practical study conducted by commissions of modern linguists and scientists, of the different types of indians and their customs, as compared to the well known types of the human family in general in other parts of the world, would produce results of an important and more reliable character.

The difference which exists between the types of Indians in respect to their physiognomical cast, general physique, customs and language, could not have been brought about by simple migration, or the separation of one part of a family from the other in the same.

The solution of this question must, therefore, be sought for upon independent grounds: for, it is highly probable,—if not quite certain,—that there existed indians who had migrated to South America, long before the period of the Inca domination, and this seems to be proved beyond all doubt, by the great difference existing in the ancient pottery frequently discovered in different parts of this country.

The investigations which I have made relative to this question, have induced me to form this opinion. It is, also, highly

probable that one of these Indian tribes, at least, originally descended from the ancient Egyptian race. Certain sculptures, and other objects in my possession, especially those of Mexico, confirm this hypothesis.

It is clearly stated by Garcilaso de la Vega, who wrote in 1609, and afterwards confirmed by the researches of Prescott and others, that the Incas of Peru, and Aztecs of Mexico, had attained a considerable degree of civilisation and organised government, and consequently, Architecture, Mechanics, Engineering of Aqueducts, Bridges, and Roads, and inventions suitable to their condition, existed and were practiced to a large extent, and that the use of the metals of gold, silver and copper, was well known to them as their metallurgical remains now prove.

Mining, and the art of converting the minerals by metallurgical processes to the form required for ornaments, utensils necessary for their religious services, and domestic use, also flourished in a very high degree; but mining was not confined to a mere search for precious metals and minerals on the banks and in the beds of streams, for we have evidence that it embraced the more formal mode of attacking the veins of mineral at the surface in the form of open quarries, and shallow galleries, and as the veins of mineral were numerous, there could not have been any reason, or necessity, to extend their workings to any considerable depth.

Some of the mines worked by the Incas were said to be situated near to Cuzco, in the valley of Curimayo to the North East of Caxamarca, and at Porco, near Potosi.

The mines within the jurisdiction of the Incas, were their exclusive property, and the common people were not permitted to appropriate any of the production for their own particular use.

Considering that the government of the Incas consisted in

a perfect protectorate of all its subjets, under which system none could become poor or rich, it is evident that the people would have had no occasion to share in the production of the mines. However, these restrictions applied more particularly to Peru, than to the tributary tribes occupying tracts of land further to the South, as in Bolivia and the Argentine Republic.

During the time occupied, in my various expeditions in the interior of the country, I discovered in several parts of the Province of Catamarca, many instruments of hardened copper, fabricated and used by the Indians, and some of these are capable of receiving a very fine and durable cutting edge, scarcely inferior to that of soft steel.

Some antiquarians are of opinion that the indians possessed a secret process for producing this effect, but others assert that this property in the copper is due to a slight mixture of tin. Humboldt, for instance, states that an instrument of this class which he took to France, assayed 0.94 °/₀ of copper, and 0,06 °/₀ of tin. I have not, however, cared to ruin my Indian instruments by subjecting them to a similar process, as I am not of opinion that the presence of tin is a sufficient explanation. Possibly these instruments do not date anterior to the time of the Incas.

Those princes had, according to history, subjugated the independent tribes of older Indians as far as 35° South latitude, but it is possible that their domination extended further South.

My own examinations have produced evidence that the Incas ruled the tribes in the territory now occupied by the small village of Cerro Negro, near Vinchina, in the Province of La Rioja.

It appears to me to be almost certain that the tribes thus dominated were the descendents of those who occupied the land long before the time of the Incas, and as I have previously noted, particular evidence of this is to be found in the great

difference existing between the *pottery* manufactured during the time of the older Indians, and that of the Inca period. This is so decidedly marked, that when once the key to the secret is present, the evidence of age is apparent.

Very few utensils of gold have been discovered in the Provinces of Catamarca and La Rioja; probably therefore, tribute to the Incas was principally paid in silver. When we consider the large number of silver veins which existed at the surface in the mountains of Famatina, Province of La Rioja, this conclusion is certain.

Some years since, a small Ink, or Paint-Bottle, beautifully made in gold, was discovered in a tomb in the ruins of an immense Indian village near the town of Tinogasta, in the Province of Catamarca, and it is certain that the Incas ruled this territory: for, to this day, these ancient ruins bear the name of *Río del Inca,* i. e., River of the Incas. The instrument of gold, previously referred to, must have been a present from one ot the Incas in Peru to *Tino,* the Cacique of the tribe of Indians occupying that place, or at least, to some other representative before the time of Tino.

I have taken considerable interest in examining the ruins of many of the Indian villages, and some deserve special notice: for instance, that of *Guatungasta,* an ancient Indian village, the ruins of which are now called *La Troya,* near the small village of *Anillaco,* a half days journey to the North of Tinogasta. At this place may be seen the circular adobe houses, evidently belonging to the chiefs of the tribe, and these are in excellent preservation.

Some few excavations have been made at different points in the ruins, and many objects of interest were discovered; for example, two of these consisted of silver coins or medals, about the size and weight of an English five shilling piece, one of which was sold to a gentleman in Catamarca, and the other came into my possession.

It is said that the first mentioned was covered with characters which, if true, renders it doubly interesting and valuable, not only from a metallurgical point of view, but for historical and philological investigations.

We have no positive information to prove whether an interchange of articles between the states of Peru and Mexico, and others adjoining, took place or not, but considering that the Incas were frequently at war, it is probable that no interchange took place and, for that reason, money could have had no object in Peru. It has, however, been stated that the Mexicans possessed a coinage system, and that the Peruvians used silver balances beautifully adjusted.

The silver pieces previously referred to must, therefore, have been medals, or tokens of distinction, sent by the Inca to Guatun, the Cacique of the Indian tribe which flourished at the site referred to, in the Province of Catamarca or, it may have been sent to some governing chief representing the Inca, either before, or after the time of Guatun.

The Indians continually traversed every part of their country for the object of the chase, searching for earths, gum, and stones necessary for paints and implements of war, etc., and they were consequently well aware of the existence, and particular situation of most of the important rich mineral veins and deposits of gold, silver, and copper, which appeared at, or near to the surface.

It is also possible that they knew of the existence of gold and silver, in the copper ore existing in certains forms and consequently would have been rendered visible by the action of fire, and doubtless this was a common practice of the Indians, especially in Peru, where the metal was extracted from the crude mineral in air furnaces built upon elevated places.

From all these circumstances, it is evident that immediately

after the conquest the Spanish Jesuits very properly availed themselves of the opportunity thus presented to them, of discovering the secret of the Indian mineral treasures. At the time of their settlement in the country, one of the chief objects was to subject the Indians to their religious system and protection, and they not only succeeded in doing this, but they cultivated large tracts of land in Misiones and other places, for the support of the Indian people, built towns, churches and schools: introduced a complete social system, and thus gained a noble and complete controul, and the entire confidence of the Indians, from whom correct information of the position of the mineral treasures was obtained. Thus, they not only secured free action and independence for themselves, but they rendered a great service to the natives, improving their general condition, and doubtless would have continued to advance the civilizing work to a high standard, had the jealousy and cupidity of their opponents given place to elements of a praiseworthy character; but the frequent demands for contingents of men and resources to aid in the defense of the seaboard settlements weakened their efforts; and eventually, the false representations made to the court of Spain by conspirators brought about the ruin and final expulsion of the Jesuits in 1767.

The discovery made by that indefatigable navigator, Columbus and his followers, and the exhibition of the immense number of rich gold ornaments, and utensils which they took to the Court of Spain, raised the spirit of the Spaniards to the highest degree ot elasticity, but as history testifies, instead of exercising clemency towards a noble but conquered race, they sought to discover the great deposits of treasure of Atahualpa, the last of the Incas.

Part of the gold and silver obtained from the Indians, and which had probably been stored up during the lapse of ages, was taken from the sacred and other buildings, and carried off

but the principal source whence the precious metal was originally obtained was entirely neglected and, perhaps, lost for ever.

There is no evidence to prove that the Spaniads commenced to work the mines in a general manner immediately after the conquest, for the inference is that they were too much glutted with gold and silver to permit of this for a considerable time aftewards. However, the mines of Porco, situated near the mountains of Potosi, were granted to Hernando and Almagro Pizarro—for military services—somewhere about the year 1539 or 1540.

They obtained large returns from the mines, by which means they were enabled to carry on Civil strife in Peru, which ultimately extended to pretensions against the authority of the Spanish Crown, and ended fatally for Pizarro.

These mines continued very productive in the hands of the Pizarros, and their chief military Captain Francisco de Carbajal, up to 1546 or 1547, but, as previously noted, the mines were worked by the Incas long before 1539, but how many centuries earlier, cannot now be determined.

The number of Incas that reigned in Peru, is much in dispute, but if we could determine with certainy the number of these princes in their succession, and the number of years each reigned, then we could fix a date when this domination commenced.

Suppose, for example, that there were 20 Inca Princes, and that each reigned 35 years, then we should have a date as early as 822 A. D., but even this would not prove that the more ancient tribes did not work and utilise the minerals which must have been found in great abundance in many parts of the surface of the territory occupied by them.

Prestcott states in effect, that Carbajal worked the mines of Potosi for Gonzalo Pizarro, and that he came upon a vein of

silver richer than any previously "discovered in Mexico or Peru". It is also stated that the vein now discovered at Potosi was so rich that the other mines were comparatively deserted in order to work it. For this authority, Don Juan Ortiz de Zárate, Governor in Paraguay in 1565. (Conq. del Peru, lib. VI, cap. IV) is quoted.

It is not clear whether the mines abandoned were those at Porco, or some older ones at Potosi; but considering that this new discovery was made about the year 1546, it is probable that reference was made to the abandonment of older mines at Potosi, and not at Porco. Garcilaso de la Vega, states that shortly after this period "an iron horse-shoe was worth nearly its weight in silver".

I was informed by a particular friend, formerly connected with the government of Catamarca, that recently a notice had been received from Spain in reference to the position of a rich gold mine, said to be situated somewhere in the Cerro Ambato, near the capital of that Province, and that it was possessed by the Spanish Crown soon after the conquest, and that the entrance to the mine had been secretly closed?

It was also stated, that the Crown of Spain possessed the rich mines of Potosi, at the same time as the gold mines referred to in the notice.

For rebellion, Gonzalo Pizarro was executed in America about the year 1548, or 1550, and his mines at Porco, and those at Potosi, must have been forfeited to the Spanish Crown. Doubtless this is the correct explanation of the notice referred to, and if so, the date of the possession by the Spanish Crown is clear, but how long this gold mine existed prior to this date, there is no evidence to show; but it, also, must have belonged to the Inca period.

Great interest was felt in Catamarca, and an exploring party was sent out, the ultimate report of which was, that nothing

more than traces of approaches to the mine had been discovered.

The establishment of a Mint at Potosi, dates as early as 1561; but, as has been previously noticed, these mines were worked at a much earlier date.

Humboldt considers that the first period of these mines extended from 1556 to 1578; but, possibly, this had reference to the more formal mode in which they were worked, and not to the superficial workings carried on by the Incas.

The Cerro de Pasco, in Peru, appears to have been discovered in 1630, and according to the best authority, the first South American Mining Company was formed in Quito, in 1557, for the object of lending money for working mines, but the result of this combination is unknown.

It appears that the Indians who resided upon the tract of territory now included in the western part of the Argentine Republic, made their last great stand against the Spaniards upon the plains and mountains contiguous to the eastern slopes of lhe Andes, it is therefore likely, that this part of South America was occupied by the spaniards at a later date than Peru and Mexico, further to the North.

A few scant notices exist in reference to mines of Gold and Silver, which were discovered on the slopes of the Andes on the side of Cuyo, near Mendoza, about the year 1638, and it is stated that many miners from Potosi went there to work in the mines, and that at a little depth, water was encountered putting an end to further progress. It is also recorded, that Father Ovalle passed the Andes in 1640, and saw these gold mines, and afterwards wrote letters from Rome referring to the subject. The letter of Father Ovalle must have been dated about 1641, or 1642.

The Indians living South and South West of Mendoza, as far as Patagonia, have a tradition that the ruin of their nation

was occasioned by the desire of the white men to obtain the rich mines which their ancestors possessed. This seemed to have created great antipathy, so much so, that friendly whites could obtain no information referring to the position of hidden mines: and such enquiries always created great displeasure.

Considering that until very recently the Pampa, and mountain Indians, were fierce warriors, and committed many depredation against the white settlers, it is scarcely likely that a party of miners could have been sustained at the gold mines at Cuyo for any considerable time anterior to, or in 1638. None others than the Jesuits could have effected this; but if they did not arrive in America before 1589, this idea also would seem to be impossible.

In 1591 the Caciques Mallí and Nono lived at the Indian villages called Malligasta and Nonogasta, governing the tribes then occupying these places, and others scattered over the adjoining camps. These villages still exist under the same names: the first being situated about 3 miles to the East, and the second some 9 miles to the South of Villa Argentina or Chilecito. It is said that these chiefs were strong warriors, and tradition affirms that their ancestors were in continual strife with the tribes residing further to the North, probably under the dominion of the Caciques Tino and Guatun, and those associated with them.

These northern tribes, inhabited the immense camps extending from Tinogasta to Fiambala, and further North in the Province of Catamarca, and from Tinogasta southward toward Campanas. The chiefs Tino, and Guatun, were also great warriors and staunch tributary princes in the interest of the Incas, and consequently, they or their descendants, must have been formidable opponents of the Spaniards; for, Carrillo states that the Indians from Guandacol, in the Province of La Rioja, as far as Humahuaca, in the Province of Jujuy, rose en mass

in 1627 against the Spaniards, so that if discord existed amongst the different tribes, they could always join against a common enemy.

The evidence of great strife is still to be seen in the immense quantity of broken Indian pottery, found scattered over the battle-fields, or encampments which extended over large tracts of country.

There is also a tradition in the Province of La Rioja,—apparently contradictory in itself—referring to an alliance entered into between the Caciques Malli and Nono with a division of Spanish troops, for the purpose of operating against the tribes further to the North, but no record of this has as yet been found as far as I am aware.

The Province of Tucuman was founded in 1563, and Don Juan Ramirez de Velazco was governor of that Province from 1586 to 1593, and he also founded the town of La Rioja, in the country of the Indians then called Diaguitas, in the year 1591.

The Indians inhabiting the country called Cuyo, were subdued by Pedro de Castillo, who received orders from General Don Garcia Hurtado de Mendoza to march from Chile with 100 soldiers. In 1559 he founded the town of Mendoza, and also that of San Juan.

It is stated that the Caciques Malli and Nono, allowed the settlement of a Spanish Colony in the large Indian village called Anguinan, Province of La Rioja, which village still exists midway between Malligasta and Nonogasta, at a distance of 2 miles South-East of Villa Argentina, or Chilecito. The settlement of this Colony is believed to have taken place towards the end of the 16th. century; probably it was not establised until after 1593, unless, indeed, the Indians in that part were subjugated from the south by the army of Pedro Castillo. If this were so, the settlement at Anguinan was made at an

earlier date than 1593. On the contrary, if the Indians were dominated by the forces of Velazco, and other forces from the North and North-East, it may have been close upon 1593, or not long afterwards, and as Anguinan is only 1 day's journey to the west from La Rioja, the latter theory is most probable.

The descendants of the Indians at Famatina, Malligasta, Nonogasta, Sañogasta, Vichigasta, and other places further South, still possess right of camp, which seems to imply that such rights must have been derived from original grants made by the King of Spain to the ancient Indians, probably for military service rendered by them in the subjugation of the tribes further North.

It has been stated that the Colony of Anguinan was founded in 1596, which is highly probable, agreeing, as it does, with the other dates.

Tradition describes the Spanish chief of the colony as a man of tyrannical disposition, and that the laws which he imposed for the guidance of his own countrymen, and the Indians, were so exacting that civil strife ensued, ending in his assassination. Some of the principal actors in this plot escaped, intending to cross the Andes to Chile; but in the gigantic mountains of Famatina they were overlaken by a terrible storm which lasted a considerable time, obliging them to shelter themselves in a natural cave which they discovered. It appear that the earth extracted from this cave was by some means found to contain gold, and they took away samples of some of the earthy mineral, and also samples of silver ore with them to Spain.

If this account is true, which is most probable, it gives us a very early notice of the mineral district of Famatina, and possibly there is nothing older on record.

We are also informed on similar authority, that soon after the establishment of the Colony at Anguinan, the missionary priests came and took up their residence in the same village.

Dominguez, in his "Historia Argentina", 1870, states that San Francisco Solano, Jesuit, came to America by Panama, in company with a large number of friars in 1589, and their number soon augmented by new arrivals; but it is probable that there were arrivals of Jesuits at an earlier date. Father Charlevoix says that Saint Francis Solano, and a great many other missionaries of his order, entered—the Province of Tucuman—on the side of Peru—between the years 1581 and 1584.

They distributed themselves over a large extent of country, and at their expulsion, which took place in 1767, they are said to have occupied 30 villages, and had domesticated 93,000 indians. Considering, however, that the Jesuits occupied the country for a considerable period, it must be believed that the number of indians civilised vastly exceeded that given by Dominguez.

It does not appear to be well established when the first Jesuits came to South America, neither is it possible at present to give the exact date of their arrival in the Province of La Rioja; but it is stated that they inmediately followed the missionary priests, and that they settled at Nonogasta, where they had a large estate called "El Fuerte de San Marcos". After their expulsion, this estate was sold by the Fiscal.

The present church at Anguinan, was erected in 1774, but two others existed prior to this date, and were constructed of mud bricks, and must have fallen to decay by the action of time. If we allow 85 years, as the probable duration of each of these churches, we should have 1604 as the probable date when the first church was erected, or 8 years after the founding of the Colony; an assumption, probably very near the truth. Unfortunately, the old books preserved in the present church of Anguinan are so faded, that it is impossible to decipher their records.

Valuable information was also lost by the destruction of the original church and all its contents, at Famatina, by fire.

The small oratorio situated at Sarmiento, 2 miles to the North-East of Villa Argentina, has a beantifully carved door, and frame, made out of the algarroba wood of the country and the lintel of the frame has the date of 21 May 1764 carved on it.

These dates are sufficient to prove that many places contiguous to the silver and gold mining districts of the mountains of Famatina, were occupied at an early period. The Jesuits would, therefore, be likely to have possessed important information of the mines from the Indians; and it is well known that they devoted considerable attention to mining: we should not, therefore, go far wrong in assuming that they possessed nearly all the richest mines, i. e., those discovered at that time.

Two such mines were possessed and worked by the Jesuits, somewhere in the mountains of Famatina, and these mines in particular have become the subject of much interest and speculation for many years past, not only in the Argentine Republic, but in Chile and other parts, and the excitement connected with the many expeditions which have been undertaken for the rediscovery of these mines, has been excessive, and has led to the expenditure of much time and money.

Copies of the old records of those treasure mines of the Jesuits exist, but their ambiguity has rendered it impossible to fix the precise situation of the mines. The documents referred to, state that one of these mines contained a vein of native gold, and the other a vein of native silver, and they have always been known under the name of Chocoy. It is also stated that they were comparatively close to one another, and that both were secretly closed a little before the departure of the Jesuits. The gold mine was said to be closed with a large flat stone brought from a considerable distance by a number of Indian workmen, who also placed it over the mouth of the pit leading to the mine, and upon this stone a large cross was cut for iden-

tification. From this it is clear that the Jesuits must have had an intention of returning to the mines on a future occasion. It is also stated that sixteen Indians could dance upon this stone at the same time.

It is a well established fact, that the Jesuits wrote a description of their principal mines, indicating their situation and nature, and at their expulsion it is believed that these documents were taken to Spain. It is also stated that they were written in duplicate, and one of them was placed in a bottle and secreted in the inner part of the walls of the Red House inhabited by the Jesuits, in a valley near the Cerro Negro, Province of La Rioja. A part of this house was still standing when I visited the locality.

It cannot be determined at this distance of time, how many mines were worked, or for what length of time, neither is it possible to estimate how much gold and silver they extracted and forwarded to Spain before their trouble came on; but, as they commanded extensive Indian labour, doubtless the quantity was very considerable.

Thus the expulsion of a race of useful civilizers, closed up, perhaps for ever to the succeeding generations, sources of incalculable wealth.

There is no evidence that mining progressed, or even was the object of much attention during the interval which elapsed from the time of the expulsion of the Jesuits to the arrival of the Aragoneses or Lay Jesuits, i. e., Juan Leita and Juan Echavarría. The date of their advent in South America, is said to be about the year 1777, or ten years after the expulsion, but the general opinion is, that it was about the year 1803. It is, however certain, that Juan Leita possessed information derived from one of the expulsed Jesuits, and that he, in connection with his companion, rediscovered several rich mines from which they obtained a considerable quantity of gold and silver; but

if we take into consideration the amount of work which these celebrated spanish adventurers are said to have performed in the Province of La Rioja and that of Catamarca, the date of their arrival in South America must have been anterior to 1803.

The mines which Juan Leita rediscovered, included "Santo Domingo", "Santa Rosa", and "Viuda", in the Cerro Negro: "Socorro", and other in the Tigre: "San Pedro", "Bartolomé" and "Mercedes" in the Caldera Vieja. The great success obtained by these indefatigable Aragoneses gave considerable impulse to the spirit of speculation as far as obtaining mining concessions went, and it had the effect of drawing miners from different parts of the Argentine, Chilian, Bolivian, and Peruvian countries, who flocked to Famatina, spying the actions of Leita and Echavarría, for the object of obtaining concessions of mines adjoining those taken up by these discovering Aragonesses.

Chilian history records that Juan Leita and Juan Echavarría resided in Copiapo, and that in 1811, they travelled by the road of the Incas in a journey undertaken to Peru, accompanied by an Indian servant, but as the latter did not know the passes of the Andes, Leita procured the services of a young man from one of the Estancias on the road, and after a fatiguing journey they arrived at the Argentine side of the Andes, but a heavy storm came on, obliging the party to search for shelter among the caves of the rocks in a narrow but deep gorge, where they passed the night. In the morning they observed that the stones which they had gathered the previous night to surround the fire, were white, and this unusual circunstance led to an examination resulting in the discovery that the stones consisted of silver. It was at once concluded that these silver stones must have fallen from some high point in the mountain into the gorge. A search was consequently commenced and after expending considerable time, the origi-

nal vein of silver mineral from which the stones had fallen, was discovered, and for future reference, a large cross was made upon it with a knife, and as much of the silver mineral as possible was taken away.

In order to guard the secret of the discovery, the party determined to travel by unfrequented roads, and in this manner the small villages were avoided but, on approaching some part of the province of Tucuman, the party was surprised by a band of patriotic *guerrillas*, soldiers under the orders of General Belgrano; but, on the approach of the soldiers, Juan Echevarria escaped, and Juan Leita had just sufficient time to enter a field close at hand, and bury the treasure of silver which he had carried from the discovered vein. He was, however, immediately surrounded and taken before the General, and charged with having received in Copiapo, secret letters and orders to carry out an important commission before the royal authorities in High Peru, tending to destroy the plans of the Government existing under regime of 25th. May and 18th. September, 1810.

In his confession, Leita made known his discovery of the silver vein, and of his burried treasure in the field.—Belgrano ordered the treasure to be disinterred and was inclined to pardon Leita, making it a condition that the latter should indicate the position of the silver vein, but consequent upon his having previously gone by difficult and unusual routes, his description was not sufficiently clear and positive to satisfy the general, who ultimately ordered Leita to be shot, vhich occurred in 1812.

Persons were living in Famatina in 1884, who knew Leita, and there is sufficient evidence proving that there are several rich mines in the Provinces of La Rioja and Catamarca, discovered and worked by Leita, which, however, have never yet been rediscovered. The stories frequently told of the

adventures of Leita are very interesting, but too numerous to be recounted.

The existence of Juan Leita is referred to at page 397, volume II, of a work written on the Argentine Republic by the French Doctor of Medecine, Martin de Moussy, who wrote in 1860 about the Aragoneses, in a doubtful manner, but the actions of Leita were of great importance as marking a particular period in the mining history of the country. The evidence proving that Leita and Echavaria came into the Province of La Rioja, and operated in the Famatina mountains, is to be found in the original book of Registrations and Demarcations of the mines of " San Pedro " of Famatina, written by the Territorial Judge by order of " Don Baltazar Hidalgo de Cisneros, Virrey de estas Provincias, " dated Anguinan 10th. June, 1810.

The record translated, is as follows " August 31st. 1810. " Don Juan Echevarria, for himself, and in the name of his " companion Don Juan Leita, natives of the kindgdom of " Aragon, presented three documents for silver mineral, asking " for three concessions of mines situated in the Caldera Vieja, " expressing that two of the said veins of mineral ran in a " North and South direction, and that the third vein had an " East and West bearing, naming the mines " Bartolome ", " Mercedes " and " San Pedro de Famatina ".

From the same document we find, that on the same day, three other mines were asked for by independent persons adjoining those of Echavaria and Leita. Also on the 1st. September, 1810, three other mines were applied for in the same neighbourhood, one of these being taken up by Don Melchor Zarate, from Potosi, Peru.

On the 9th. September, 1810, Don Juan Echavarria again presented himself before the Government authority asking for the concession of a mine on behalf of himself and Juan Leita, to be taken upon a vein of mineral to the East of the said

"Bartolome", and about four cuadras distant from it, which vein bore North and South, and called "*Veta Azul*". On the 8th. of October, 1810, Juan Echavarria presented to the Territorial Judge a document correcting the direction of the veins of mineral in the mines applied for on the 8th. of August previously noted.

No further record of the Aragoneses can at present be traced, and as the Chilians assert that Leita and Echavarria resided in Copiapo in April 1811, and that Leita was shot in 1812, it is probable that the records under notice refer to their last mining acts in the Province of La Rioja, and also that the mines taken up by them in the Caldera at the dates mentioned, could not have been exploited to any extent or for any considerable length of time.

The Register Book referred to, and from which I have taken these notes, was commenced in 1810, and closed in 1824; it therefore contains notices extending over a period of fourteen years.

It is probable that mining was first commenced in the Famatina mountains by Europeans about the end of the 16th. century, or say 1596, or 1599, for we have evidence that further South, in the part now called the Province of Mendoza,—formerly part of the country called Cuyo,—mining was commenced 39 years afterwards. The part called Cuyo seems to have included tracts of land now forming the Provinces of Mendoza, San Juan, and San Luis, embracing the Eastern slope of the Andes westward to the frontier line now dividing the Argentine and Chilian Republics; Huspallata, or Uspallata, being included in the former Province.

A record is still extant informing us that in 1745, certain commercial men of Santiago de Chile, formed the idea of exploiting the mines of the Cordillera, and in 1755 a company was formed with 27 shares of 100 dollars each. In 1756, this

company was launched under the title "Sociedad Minera de Uspallata", but with what result is unknown. Probably these were the gold mines of Cuyo before referred to as having been discovered in 1683, but it is difficult to see what progress could have been made with a capital of 2.700 dollars.

Another authority, Graty, informs us that the mines of "San Lorenzo" de Uspallata were known from the 17th. century, and also that from the time of the Spanish domination, there existed at the same place important works of exploitation of mines of gold and silver, and further that the mines of "Uspallata" were discovered in the year 1638, and that their exploitation commenced in the year 1776.

There seems to be some confusion of dates, but it is probable that, as has been previously stated, the year 1638 referred to the period when the mines were first worked, perhaps by the Spaniards, whereas the date 1776 must have represented a period of later and distinct exploitation.

In the history of Paraguay, written originally by Father Charlevoix, and reproduced in England in 1769, it is stated that "in 1558, Don Juan Gomez de Zurita founded on the road from Santiago to Chile a Fortress, to which he gave the name of Canette, and which was since, when converted into a town, called New London, in honour of Mary Queen of England; and of Phillip II, King of Spain. But there remains nothing of it at present".

Thus it appears that the Indians destroyed the first town of London, and it also seems that Don Gregorio Castañeda destroyed it betwen the years 1562 and 1563.

However, some more modern historians state, that the town of London was built in 1588, but that may have referred to the erection of a few houses surrounding the Fortress of Zurita.

The dates are somewhat conflicting, because some authors

place the building of London between 1562 and 1597, and after its destruction, its reconstruction in other parts.

Father Charlevoix also states that, "in 1631 a new Citadel was built to awe the Indians", and that, "the town of London and Citadel were destroyed by them immediately afterwards". From all this it appears to be clear that London, or Londres, must have occupied other sites. *

The general hostility of the Indians, appears to have abated about 1639 or 1641; but there was an uprising in Salta in the year 1670, but whether it had a general character extending to Catamarca from Salta, or not, is doubtful.

The great Royal Road of the Incas traversed a very mountainous Country from Peru, at least as far South as *Puente del Inca,* in the Province of Mendoza, the remains of which are still visible; consequently it is clear that the Indian tribes had access to all the mining districts *en route;* and it is believed, and generally stated, that one of the Inca Princes worked a vein of mineral for gold, in the mine now called "Restauradora", in the Cerro Capillitas, situated in the Province of Catamarca; but it is also reasonable to infer that the attention of the Aborigines was not directed to this mine alone.

The limited time at my disposal has prevented a proper examination, such indeed as would have been necessary for the discovery of evidence relative to the particular mines worked by the Incas, and afterwards by the Spaniards, in the Cerro de Capillitas and other neighbouring districts; but considering that the ruins of furnaces and deposits of escoria, have been discovered at the base of some of the mountains, mining and smelting operations must have been carried on

* Since writing the above the interesting and important work of Mr. Samuel Lafone Quevedo has appeared on London and Catamarca, and he has clearly stated the facts, and there is an agreement between him and Father Charleroix as to the founding of Londres in 1558.

to a considerable extent, either by the Indians, their Spanish conquerors, or by both.

Sufficient evidence, however, exist to prove that the Jesuits worked mines in the chain of mountains of the Aconquija, and it is reported that there still exists at the top of this mountain many roads and ruined buildings, and these circumstances alone led to the conclusion that mining operation must have been carried on there for a considerable period of time.

In the year 1881, a bell was found weighing 1 quintal, on the side of the Cerro Aconquija, and it came into the possession of one of the members of the family of General Navarro. There are many traditions referring to ancient mining in this Province, and to rich mines discovered by Juan Leita, the great Aragones pioneer of South America, and others, and also to those mines hidden either by the Indians, or in later times by the Jesuits.

The following embraces one of the most authenticated accounts of its kind. " Don Manuel T. Rodriguez, stated, that " in the year 1847 he saw in the possession of Don Tomas " Valdez, of the Rioja, a manuscript consisting of about 4 " pages which actually contained a history of the position of " hidden mines in the Cerro de Ambato, in the Estancia of " the Priest Cordoba. It is stated in this history that one of " these mines was covered over with large slate stones, and " it appears that a part of this Estancia was named Piedra " Parada, from which Rodriguez affirmed that the history " pointed out as being the starting point to the hidden mine in " question. It seems, also, that on one occasion a particular " search was made, according to the directions of the history " refered to, and that ultimately a large stone was actually " found which appeared to cover up a mine, but it is stated " that this spot could never be found afterwards. "

It is a well known fact that for several years previous to, and

up to 1846 or 1847, the father of General Navarro continually bought rich gold mineral, brought to him by the Indians of the Cerro Ambato, and it is also stated that this gold was obtained from a locality called Cuesta de Jallango.

Don Mardoqueo Molina, of Catamarca, is said to have possessed many ancient histories referring to hidden mines in the Cerro Ambato, and so firm was his faith in the truth of these accounts, that he was induced to despatch many persons at different times in search of the hidden mineral treasures; but although he expended a considerable sum of money in this kind of adventure, nevertheless, he made no rediscovery.

It is stated that in the years 1826, an English Society made a proposition to the government of Catamarca to purchase the Cerros de Aconquija and Ambato, and that a certain sum of money was advanced, but that the parties concerned were killed on the way to Europe.

It is also reported, that at the time of Rozas, about the year 1848 or 1849, another company petitioned the government of Tucuman for the object of working mines on the Tucuman side of the Cerro de Aconquija. The government passed the petition to Rozas who ordered that it should not be accepted, and also caused the expulsion of the persons who had made application for the concession.

In the Cerro de Capillitas, at a distance of about 15 cuadras to the South-East of the "Restauradora", exist the remains of an ancient furnace which must have been used by the early Spaniards, or the Indians. A similar ruin was also discovered near the entrance to the mine "La Argentina", and a large piece of escoria from it was secured by Uladislao Augier. Also at Chanar Punto, one league to the south of Santa Maria, the, remains of old Smelting Funaces also exist, and in 1853, 8 or 10 *cajones* of mineral also existed at the same site.

Near the Rio del Arenal, 5 leagues from Capillitas, in the di-

rection of Santa Maria, there are to be seen ruins of old smelting establishments, and also mineral dressing floors and antique stone implements used to crush the mineral. In the Cerro Bayo, there are indications of ancient mine workings, and from Becobal, to the south of the Punto of Balastro, a large road, walled on each side, was discovered in 1853, but on arriving at the top of the Cerro, it terminated. There are also remains of ancient pits and other workings considered to belong to the Indian period.

In making a ditch some years since, at Fuerte Quemado, to the North of Santa Maria, nuggets of gold of large size were discovered, and Uladislao Augier, of El Fuerte, purchased one weighing half an ounce, but the others were larger. At this place, also, there were indications of ancient gold washings.

It is generally reported, that the king of Spain would not permit concessions of mines to be granted in the Cerro de Ambato, but ordered that it should be reserved as a royal possession. This indicates the high estimation in which this Cerro was held at that time for its capabilities to produce mineral wealth from the mines then in existence.

It is stated on good authority by persons of credit who resided in Catamarca, that near to the top of the Nevado, which is a very high Cerro covered with perpetual snow, and situated to the North-East of the Fuerte de Andalgala, the Jesuits worked a gold mine on the Tucuman side of that mountain, and that at their expulsion, this mine was shut up by a stone wall which they erected twenty varas or 18 yards in height. This wall was erected in such a form as to retain the water which came from the mountains by 3 different streams which seemed to have united at a point in the mountain enclosed by the wall; thus a kind of lake was formed, the water eventually running over the wall, so that the mine has not been rediscovered up to the present time.

It is also stated, that an Englishman, offered to the Provincial Government of Catamarca 1.500,000 dollars, to be allowed to drain off the water in this lake, and to take possession of the mine. He seemed to have proposed to blow down the wall with gunpowder, but some of the authorities considered that the body of water which would thus have suddenly been set at liberty, would have been calculated to inundate the inhabitants living at lowers levels; consequently, the proposition was negatived by one vote. If this story is correct, the facts ought to be recorded in the Archives of the Government of Catamarca; but I have not had the necessary time at my disposal to search for the documents.

In the mountains in the neighbourhood of Rio Blanco, Agua Negra Muerta, and in various other parts of the Province of Salta, exist a number of abandoned mines and establishments of reduction, also heaps of refuse from the mines and pits and also escoria, so that we are led to conclude that the people who inhabited these parts were numerous. La Rinconada in the Province of Jujuy, is a gold bearing district, and there is evidence of extensive ancient workings, both as regard veins proper, and alluvial washing.

As in various other parts of the Republic, there exist evidence of three epochs of mining; i. e., that of the Aborigines, the Spaniards, and those of more modern times. It has been proved in the preceding part of this history, that the Indians must have commenced mining operations in the Provinces of Salta, Jujuy, etc., at very remote periods, and doubtless it was the ancient mining indications left by them which first led the Spaniards to examine the mining districts, and to select those regions which they considered to contain the richest gold and silver mines. Their energies were, consequently, vigorously exerted with the hope of obtaining great mineral wealth, and mining operations were carried on by them to a considerable

extent, as far as their limited resources, and mining knowledge permitted.

From all these considerations, it is reasonable to infer that they obtained considerable quantities of gold and silver.

The town of Salta was founded in the year 1581; but there is evidence that mining operations commenced long prior to that period. The Indians, indeed, must have devoted their attention to the mines long before the conquest made by the Spaniards.

How long the Spaniards were engaged in this enterprise there is no evidence to show, but it is certain that they were engaged in mining operations down to 1670; and possibly to a much later period.

Nothing certain is known when the mines of Acay were first discovered and worked; but, beyond all doubt, as previously indicated, they were ancient Indian mines: neither is it very clear when the Spaniards first commenced to work the mines, but it is likely that it was immediately after the conquest.

In a document which Don Manuel Sola obtained for me from the Archives of Salta, it is stated that in the year 1655, the Governor and Captain General of the Province, summoned the Town Council and some of the principal men of Salta, to consider the best means which could be adopted in order to facilitate the erection of a water mill, and other machinery, to reduce the mineral extracted from silver mines situated at a point called the "Ledge" of the True Cross, a peak of the mountains of Acay which was situated at a distance of 30 leagues from the Town of "Lerma, in the valley of Salta, Provincia de Tucuman".

The Governor General and Town Council seem to have been very anxious for the success of the undertaking referred to, and an official order was issued that 30 Indians should be placed at the disposition of the parties undertaking the mining enterprise, mentioned in the old document.

Great expectations were entertained, by the Governor of that time, that the tax of 1/5 of the produce of the minerals due to the king of Spain, would amount to a considerable sum.

Very little, however, is known of the progress made at the mines of Acay, from the date referred to; but, Dean Funes in his history of the Argentine Republic, refers to the destruction of the smelting or amalgamation establishment, and other work connected with the mining enterprise, by the Calchaqui Indians, during a rebellion which took place against the Spaniards, located in the neighbourhood of Acay, in the year 1670.

The exploration of the mines could only have been carried on for a period of about fifteen years.

The rebellion referred to, did not, apparently, arise from ill treatment of the Indians on the part of the Spaniards, because each man engaged upon the works received one *hard dollar* per day, and consequently, in this respect the Indians were equal with the Spanish workmen.

The rising of the Indians against their employers, was occasioned by the intrigues of a bad character, of Spanish origin, and leader of a band of Indians who inhabited another part of the valley of Calchaqui. How long the disturbed condition of things lasted is unknown, but from another record, we learn that the Spaniards were again working the mines of Acay in the year 1692.

It is, therefore, highly probable that these mines and establishments for the reduction of the minerals, were restored soon after the year 1670, but up to the present date, no notice has come to hand when the Spaniards finally abandoned the very notable and extensive works of Acay.

The mines situated in the district of Acay may be considered as divided into three groups: that is to say, 1st., those of the Rio Blanco, 2nd., those of the village of the Chapel, and

3rd., those existing in the inmediate neighbourhood of Acay.

The mines of the Rio Blanco are situated at a very considerable altitude, on a rugged part of the mountains overlooking the river itself, and this group is represented as consisting of fifteen mines, from which were extracted mineral of various kinds. One of the veins of minerals worked by the Spaniards in this mining district, is said to have had a thickness of 60 inches and ran from the South Western to the North Eastern side of the mountain.

A smaller elevated plateau, marked the site selected by the Spaniards for the mining operations, and, at one time, eight entrances to the mines were visible; also a considerable amount of debris extracted from the mines, and deposited on the side of the mountain existed. A large quantity of "soap stone" or *Steatite* also remained piled in heaps with the greatest regularity.

A road, three leagues in length, was excavated by the Spaniards leading from the mines to the reduction establishments for the object of facilitating the transport of the minerals extracted from the mines.

Every circumstance connected with the mines of Acay, prove to a demonstration, that they were a source of great profit to those engaged at that time, in mining enterprise. However, during the lapse of time, changes have taken place in parts of the rugged surface of the steep mountains existing in this district, resulting in the filling up of many of the old entrances to the mines.

Considering the many cross veins of mineral which existed, and doubtless exist at the present time, and the very favourable configuration of the mountains of Acay, it may be considered strange that the Spaniards did not avail themselves of such conditions, and drive adits so as to intersect the veins of mineral at greater depth, and so facilitate and reduce the expen-

ses of their mining operations; but, instead of this, they sought the highest points of the veins of mineral on the side of the mountain, and commenced to work upon them in the direction of their inclination regardless of system or economy. This practice indicates, in the clearest manner, that they confined their attention more particularly to superficial working, where they must have found abundance of mineral without going to any great depth, for their explorations never exceeded 40 or 50 metres in perpendicular depth. This remark applies to all the other mines which were worked during the Spanish domination in the province of Salta.

The minerals in the Rio, or river Blanco district, consisted of silver and copper, and assays which have been made in modern times from samples of mineral which came from those mines, contained 15 % of copper and 41 marks, or 142 oz of silver per ton.

In some of these mines the mineral is said to have had a dark colour—an ambiguous mode of expressing it—whilst, in the mine called the "Verde", it had a green colour, as its name implies, and, consequently, we must consider it to be a green carbonate of copper, most likely carrying a large per centage of silver, as is frequently the case.

Samples of minerals which have been obtained from this ancient mine, or from its spoil banks, were assayed to contain 51 marks, or 183 oz of silver per ton.

It is a curious circunstance, that in nearly all cases the body of the mineral veins in the mines of the River Blanco, consisted of a bluish tinged quartz, and for this reason, some of the miners were induced to consider that it contained, or ought to contain gold: however, this idea has not yet been realised.

The mines of the River Blanco are the nearest to the ancient reduction establishement; the next in order being those of the old Spanish village of the Chapel, which originally existed in

that neighbourhood, but of which now only remain the ruins of 40 houses, and the old Chapel.

The area covered by the ancient village, as far as it can be at present traced, is considered to be about 19,600 square metres. It is interesting to note that each house in this village was arranged to have sufficient space on the outside, and in connection with the living rooms, for a deposit of minerals, a part of which space was occupied by rude machinery for carrying on the process of amalgamation and extraction of the silver, the mineral was first pulverised by means of a peculiarly formed heavy stone, the under side of which had a curved form and the upper part being attached to a long lever for the purpose of giving motion to the stone in the primitive Indian style, which system in still continued in the more remote places.

The old Spanish village, previously referred to, was formed upon the site of a beautiful stream of water, and the mines were situated at a distance of about half a league. These mines presented evidence of extensive workings having been carried on, and some of the entrances to the mines were, á few years since, in a perfect state of preservation; nevertheles it is stated that no persons have entered them of late years.

The mines nearest to Acay appear to have been worked at the same period as those of the village of the Chapel, for they are situate at a distance of one or two leagues from the latter.

As has been previously indicated, the remains of the ancient establishment of reduction can still be traced, as also the channel $1\,{}^{1}/_{2}$ varas in width which was made by the Spanish miners to conduct the stream of water used as motive power to drive the machinery for pulverising and amalgamating the mineral. The ancient machinery appears to have consisted principally of a water wheel, connected with circular stones which revolved in a similar manner to those of a modern

mortar mill, and so pulverized the mineral sufficiently fine to be treated afterwards by the rude process then in use.

Many of these ancient vestiges now rest in the midst of cultivated fields, and are surrounded by the small dwelling houses of agricultural labourers. The old machinery referred to is doubtless the same as that mentioned by the Governor and Captain General of Salta in the year 1655.

All the mines referred to are situated towards the South of the Cerro Nevado de Acay; and the mining district of San Antonio is situated to the North of the same "Cerro"; and there also, the Spaniards worked some of the mines. The mineral consisted of what is known as *Paco* silver; that is to say, it contained that metal in a ferruginous base. Tradition conveys to us the idea that during the latter period of the Spanish domination, a large quantity of native silver was obtained, and so rich was the mineral that the silver was in a state of semi-bar.

One of the groups of mines in this district is called "Quebrada de las Minas", and one of the principal mines worked by the Spaniards was that of "Concordia". In the Southern part of the mine exists an ancient adit, and it is affirmed, on the strength of tradition, that this mine was originally known under the name of Mina del Rey, and that the works were directed by a Spaniard of the name of Tamis, and that 40 workmen were employed. It has also been further stated that the workmen were Spanish miners, but others have advanced the opinion that they were Indians. The probability is however, that they consisted of a mixture of the two.

Another group of mines in this district is called "Angosto de San Antonio", and in this neighbourhood three rivers are said to meet; that is to say, Arcaroque, Organello, and Chorrillos, and that on the banks of these rivers auriferous sand exists, as also, the remains of a number of ancient "lavaderos"—gold

washings—as well as those of a more recent period. Near to "Angosto de San Antonio" may be traced the ruins of an antique establishment, and the mineral locality near to it is called "Rangel" and the copper mineral is said to have been of such a rich character that the name "San Antonio de los Cobres" was given to it. In this neighbourhood exist, also, the ruins of furnaces of fundition and houses which were constructed in the times of the Spaniards.

At the place called "Chorillos", may also be traced the ruins of ancient establishments, which apparently were of two clases; viz, one of fundition, and the other of amalgamation, and in these it is believed that the minerals from the mines of "San Geronimo Viejo" were treated. The old establishment of Pompeya was situated close to "Angosto de San Antonio", and about a league from the village of the Partios. From the large quantity of *relabes*, tailings, which still remain from the process of amalgamation of the mineral, we must conclude that mining operations were carried on to a very considerable extent in the mine "Concordia" by the spaniards; and extensive ruins of ancient furnaces, grinding machines, mineral floors, houses, etc., with that of a Church, prove that a large population must have been concentrated in that neighbourhood.

Both the mine "Concordia", and probably others, with the old establishment just referred to, belonged to the Spanish Government, and Señor Tamis, previously referred to, had the management of the entire concern for the account of that Government.

Jujuy appears to have been founded in the years 1562 by Velasco; whose principal seat of Government was at Tucuman.

Some confusion exist with reference to the exact date when the town of San Juan was founded, some authors placing it in 1561 and others in 1591; however, I am of opinion that for many reasons it is prudent to accept the former date.

It appears that at the conquest, or immediately afterwards, the Indians of Cuyo—which included the present provinces of Mendoza, San Juan and San Luis—pretended that they knew of rich gold mines, and made plausible offers to indicate to their conquerors the sites of the mineral riches: the Spaniards believed these reports, and an expedition was organised and guided by the Indians until at length, after some days travel, the Spaniards found that they had been deceived and led into a desolate place without water or other resources, where the Indians finally abandoned them during the night.

However, still believing that they were near to the gold fields, the Spaniards decided to found a settlement which is the site now occupied by the town of San Juan.

It is reasonable to suppose that immediately after they had made diligent search in the mountains for the indicated mines, success must have ultimately rewarded their labours; however, it is much to be regretted that the records of their first mining operations appear to be lost. It is known that Mining was carried on by Señor Soria in the year 1716, and that these were carried on in gold mines believed to be situated near to the Andes.

The mining district of Gualialan appears to have been discovered in 1757.

In the Cerros of Cordoba, and in the province of San Luis, exist various Indian images of animals and other signs engraved upon the rocks.

This is also the case in parts of the province of La Rioja, and that of Catamarca, proving that these situations were well known in remote times. It is certain that this is one of the best proofs that they had a knowledge of the mines in those localities.

The Abbé Molina wrote a history of Chile in Italian, and this work was translated into Spanish and published in the

year 1788. On pages 96, 97 and 98, it is stated: " The most " famous copper mine yet discovered in the kingdom of Chile " was that ot Payen, which, at present, is not worked because " the Puelches who possess that district will not permit it; " but, when excavations were first made masses of pure " copper were extracted of fifty and one hundred quintales in " weight.

" Histories of those times record that this copper was of " such excellent colour, that it appeared to be a true resem- " blance of gold, because, generally, it contained more gold " than copper, and to extract it, it was sufficient to light a fire " beneath the mass of stones impregnated with such pre- " cious metal.

" In the district of Curicó, another mine was more recently " discovered similar to the above, in which Gold was found " mixed with the copper in equal parts ".

The Abbé Molina substantiates his former remark by a quotation from the "*Gazetero Americano*" as follows:

" All the parts of the Cordillera in the directions of Santia- " go and Concepcion, abound in mines of this metal (copper), " and especially a site which they call Payen, where in an- " cient times some mines were worked, and in which masses " were found weighing fifty and one hundred quintales of " pure copper ".

On the same page, the Abbé refers, in a second note, in vol. I, page 145 to the travels of the French writer, M. Frezier, published at an earlier date. The quotation is: " Entering in by " the mountains of the Cordillera, innumerable mines of all " classes of metals and minerals are found, especially in two " *Sierras* which are only at 12 leagues distance from the Pam- " pas of Paraguay, and one hundred leagues from Concep- " cion (Chile); in one of which, such singular mines of pure " copper have been discovered that masses weighing more

" than one hundred quintals were found. To one of these " places, which the Indians call Payen, — copper — Don " Juan de Melendez, author of this discovery, gave the name " San José.

" I saw a mass of 40 quintals from which six field pieces of " 6 lbs. bore were made whilst I was in Concepcion; and no- " thing is more common than to find stones composed of parts " of perfect and imperfect copper, which gave rise to the sa- " ying that the earth of that place was *Criadera,* that is, that " the copper had its birth, or always grew there in great abun- " dance. This same mountain contains mines of *Lapislazuli;* " and the other, close to it, which the Spaniards call Santa " Ines, is exceedingly notable for the abundance of lode-stone, " of which it appears to be entirely composed ".

Recently, an old Chilian miner came to Buenos Aires, and reported that he had for several years been engaged in searching in the mountains to the East of the Andes for the lost mines recorded in the notice of the Abbé Molina, and that he had been successful in making a rediscovery.

Some excitement was created and, in August 1887, seven solicitudes were made for concessions of mines in the National Territory of Pampa Central, to the South-West of the Sierra called Lihuelcalel, and the petitions for the Concessions came to the National Department of Mines and Geology to be considered and granted.

Samples of the copper mineral were also presented, and the assays made in the Laboratory of the Mining Department, gave an average of 4 °/₀ of Copper without silver or gold. It is certain, therefore, that the copper mines so rich in gold as the notices tell us, have not yet been rediscovered.

Some recent Maps exhibit the mountains of Payen as being situated to the North-East of the junction of the Rios Barranca and Grande, with the Colorado, and it must be somewhere in

these mountains where the ancient mines under consideration were said to exist.

Considering that a pass through the Andes has recently been rediscovered, offering every facility for transport, no great difficulty would have arisen in the carriage of 40 quintals ot metal to Concepcion.

It is interesting to note, that the Guarani Indians of Paraguay, informed Don Juan de Ayolas, that by marching Westerly overland in about 20° 40' of latitude, he would find other Indians who had a great deal of gold and silver. Ayolas therefore organised an expedition in 1537, which was intended to last six months, and set out in search of the gold and silver mines from which the Indians had obtained the precious metal.

Nothing more was heard of him, excepting a story told by a friendly Indian. It is as follows: "Captain Ayolas on his arriving among us communicated to our Cacique his design of penetrating further in order to discover from whence the Indians had got the gold and silver that had been found among them.

As he was but badly escorted to undertake so long, so painful, and withal so dangerous a journey, our Cacique gave him a reinforcement. He set out, and at last after many skirmishes with the Indians, he found out what he had come in quest of.

At length he returned back to our Country loaded with Gold and silver, and our Cacique gave him more. He then told us that he intended to join his countrymen—the Spaniards--whom he had left with his barks on the Paraguay. Upon this our Cacique ordered several of his subjects to assist him in transporting his treasures to the river, and I, (the Indian who told the story) was one of the number, and at last, arrived at the place where he had left his barks, but they were no longer to be found. Some Paraguayan Indians deceived us, made an attack, and killed many of the Spaniards and of my countrymen. Captain Ayolas was also killed, but I escaped".

Father Charlevoix, the author previously referred to, was a very accurate observer and writer; we must therefore conclude that the story is not only correct, but carries with it a considerable amount of interest; nevertheless, the circumstance is surrounded with some difficulty.

We have it stated, that the Guaranis received Ayolas in a very friendly manner at the place on the Paraguay where the City of Assumption was aftewards built, and it was here, as I take it, that he received notice of the Indians possessing the gold and silver; but after he had advanced from the Assumption, Northward up the Paraguay River to 20° 40' of latitude, we do not hear that he encountered any more Guaranis; we are therefore led to conclude that it must have been the Indians of the Assumption that indicated the parallel of latitude, referred to; but it is very difficult to understand that they were able to distinguish such a fine geographical point as above indicated from which Ayolas should start in a westerly direction in search of the mines of gold and silver.

We can hardly think this is possible, for, looking at the map we are struck with surprise at the bold idea of a man attempting to travel such an immense distance through deserts and warlike Indians, and to encounter a host of almost insuperable difficulties in order to search for, and discover the land of Peru. The story confirms that he and his party had collected and brought back considerable wealth, but the place from whence it was obtained is uncertain.

If the gold and silver referred to existed amongst the Guaranis, as probably was the case, in the Southern part of Paraguay, it is much more probable that it was obtained from mountainous regions much less distant than Peru; it could have, in fact, been procured from the hilly country in the tract of land now known as Missions, or from the Western mountainous regions of Brazil, which divided that country from the

Guaranis, and this leads us to notice, in a cursory manner, the historical and interesting land of the Jesuits, Missions.

Some few expeditions of scientists and others have, at different times, been undertaken with a view or exploring this vast tract of land; but these have been too feeble in their character to enable them to thoroughly investigate or to achieve any important discovery.

Every inquirer must conclude that Missions was one of the principal centres of action of the ill treated Jesuit Fathers. These dangerous places were occupied by them at a very early period in the history of South America, possibly anterior to the year 1610; but, unfortunately, there is no documentary evidence to hand by which we could assign the date when they first commenced mining operations.

It is, however, probable that the possession of gold, silver and copper would have been an almost immediate necessity, and I think we should not do wrong in inferring that they commenced mining soon after the founding of some of their towns, concentration of the Indians, and introduction of good Government.

I have been unable to discover any printed records of value referring to the number and importance of the mines worked by the Jesuits, which is a clear proof that the matter has not been considered of sufficient importance, or that the observers and voyagers were more capable of directing their attention to the agricultural prospects, the variety of trees and plants, growing in Missions, than to the mineral resources and nature of the mountains from which the Jesuits extracted mineral wealth.

The Jesuits were very keen and reliable observers, and did nothing without making corresponding notes and references.

Documents of their time, and possibly, also, maps of the

sites of their mineral workings doubtless exist in the Archives of their descendants and others. This seems to be confirmed by a notice just received, from a person living in the Gran Chaco, who possesses an old map made by the Jesuits of Missiones, and it is said that the site of their mining operations is marked upon it. An old priest is said to have presented this map to the person who has it, but the latter is too egoistic to allow any one to inspect it. Its date appears to be about 1700, or a little before.

One of the mountain chains of Missiones, runs in a North Westerly direction almost parallel with the Rio Uruguay, as laid down in a plan made by the Topographical Department of the Province of Corrientes in 1882. At one point in the Southern part of these mountains we have marked, "Ensayo de minas de plata hecho por los Padres Jesuitas", and to the extreme West of this mountain we have "Canteras de Piedra", or the quarries whence the Jesuits obtained the stone for building their edifices. It is further clear that they not only worked for copper; but also worked mines of gold and silver as well, and we are obliged to believe that the gold mines, they possessed were a source of great riches.

It has been previously noticed in this chapter, that traces of the old Indian workings in the Province of San Luis, have been recognised in the Cerros Gigantes and Rico, the latter being generally known by the name of Carolina, in a part of which, it is said, that galleries were made in the XIII century, but it is not stated by whom.

If such galleries really existed, indications of them should still exist, and it is probable that they were made by the Incas, because, as has been previously stated, their domination by the Spaniards did not take place till afterwards. Without further evidence this tradition must appear doubtful, and remain in obscurity.

It is asserted, on somewhat better authority, that in the month of April 1640, a vein of gold in nearly a pure condition, was discovered by means of the intersection of a gallery in the Cerro Rico, Province of San Luis, and that, in the latter week of that year, the galleries in the mines were filled with debris, arising from a fall of the roof burying alive a great number of Indian and Spanish miners.

Other fantastical traditions exist referring to immense quantities of gold having been discovered in some ancient mine workings in the Cerro Gigante, but the surrounding circumstances lead us to form a very unfavourable conclusion.

Within the last few years, it has been discovered that in certain documents of title of property belonging to the family of Luis Lucero, there are indications, or records, that gold was found in the Cerro Rico of La Carolina, by a Portuguese monk, Geronimo (Jesuit), also in the year 1786. Señor Sobremonte, Governor of Cordoba, gave instructions that the workings of the mines should not be hindered, and that they, the proprietors, should pay to Bartolome Arias Renzel 1 °/₀ of the proceeds for the remuneration for his services as a mining expert.

In the year 1792, the Viceroy communicated to the Governing authority of San Luis, that the boxes of mineral which had been sent to Spain had been assayed by the professor of Chemistry, Don Pedro Gutierrez Bueno, and found it to contain native gold with 38 decimals of silver to every 100 parts. The other sample was assayed and classed as an auriferous Sulphide containing 7 °/₀ of Silver. The king of Spain further commanded that instructions should be given to the Intendente of the Province, the Marquis Sobremonte, that he should direct particular attention to the encouragement of the exploitation of these mines by private individuals.

Special instructions were also given by the King to the effect

that " if there should be any benefit from the metals extracted " by the machines, which it is supposed are now being used, " the establishment of a Bank or deposit should be considered, " in which your Excellency should deposit the gold obtained " by founding, and also the 3 m/c. Royal dues to be paid in " the same metal on a corresponding principle to the mint of " Chile or that of Potosi, according as it may be most conve- " nient; the dues or State rights to be despatched to the second " named place for the purpose of coinage on account of His " Majesty, or being despatched by your Excellency to Spain " converted into bars. The above are the Royal instructions " which I—the Viceroy—convey to you for your information."

In the year 1793, the Marquis Sobremonte visited the gold mines of the province of San Luis, which were then called "El Dorado", and the Royal standard was raised and floated over the mountain Tomolasta, in the Cerros de la Carolina.

"The blastings which are said to have been carried on in the Pique Hondo (65 metres in depth) in the mines Carmen, San Fermin, Labores Blancos and Southern adit, and that of the Cerro Rico, are said to have been commenced from that date."

It is stated that one of the principal mines was "Lafinurs"; but consequent upon the war of independence, and the entrance of much water into the adits, the workings in the mine were abandoned.

However, it is stated that in the year 1840 and following years, the adit of the Cerro Piñero was reopened; but the vein of mineral was not reached. It further appears that Señor Olmos opened the pit over the adit under the Cerro Rico, and it is believed that a large quantity of gold was obtained from the mine.

The ruins of many houses still exist, and also a road leading from Moyano, passing by many well known places now found upon the map of the Province to La Carolina; all

of which seem to indicate that mining must have been carried on to a considerable extent in former times; but when reference is made to the large quantity of gold extracted from the mines, we have to consider the difference of ideas which existed in those ancient times and the present; for what they may have considered to have been great quantities may now be taken in a comparative sense, and estimated at a less value.

In about 1901, the ruins of a very extensive Establishment for the reduction of copper mineral to regulus was discovered in a place called Arenal, situated at a distance of about 2 leagues in a North Western direction from the copper mines existing in the cerro of Capillitas, in the province of Catamarca.

Mr. Letrange examined these ruins and found a large piece of regulus which had been produced in this old Establishment and accidentally left behind. This large sample of regulus was presented to the writer and contains at least from 65 to 70 % of copper, with an undetermined quantity of gold and silver.

Doubtless the copper ores reduced in this ancient establishment were obtained from the mines in the cerro de Capillitas, and, probably from mines situated in other surrounding mountains. This not only seems to be certain from the ancient workings in the copper mines, but also from the name given to this mining district.

The word, *Capillitas,* establishes the fact that the Jesuits had a small Church at the old mines, or at the establishment of fundition, and hence this region was afterwards known as the Cerro de Capillitas.

Unless an extended search were to be made in the Spanish archives and Jesuit colleges, it would be impossible to give the date when the old establishment of fundition was first installed, or how long it continued; but it is highly probable that the date would fall somewhere between 1720 and 1760.

CHAPTER II

Historical Sketch of Modern Mining, etc.

We have already mentioned that the Aragoneses, created great interest in the mining industry in the far famed provinces of La Rioja and Catamarca, in the former of which they were pioneers and initiators of the second epoch of mining in the Argentine Republic. To say nothing of the gold mines distributed over the various localities, the silver mineral veins were so numerous, rich and easy of access at the surface, that many small companies were formed for their exploitation, thus we find from some records, in the possession of the writer, that the number of persons who were occupied directly and indirectly in the mining districts of Famatina amounted to 214 in the year 1817. However, only a year afterwards the number of miners had decreased to 173. Between the years 1818 and 1822, the number of miners had increased to 313; but in 1825, had again diminished to 140. In the year 1837, they reached to 304; but 10 years afterwards, or in 1847, the number of miners had diminished to 268, and in 1854 no more than 59 miners were employed. These differences were caused by the troubled times or civil wars which fre-

quently raged in the interior of the country and from lawless bands of robbers who committed every class of depredation.

Due to this cause, it is to be deplored that the archives in the provincial towns were destroyed and, consequently, the register of mines referring to the mineral districts in the Famatina mountains from 1825 to 1830 could not be found in the offices of the government when the writer made a search.

There were 12 mines in exploitation in 1816, and 147 granted; but not worked, and, in 1847, there were 11 silver mines in exploitation, and 40 mines of the same class closed in the mineral district of Cerro Negro. In the Caldera district, 9 mines of silver had been closed, 3 of which were formerly registered as belonging to the Aragoneses i. e., of Juan Laita and Juan Echavarria.

Mines of gold and silver also existed in the district called Rosario del Oro; but, at the period referred to, 26 of these had been closed. Also, in the other mineral districts all the mines were closed, i. e., La Mejicana, 5 mines of gold; Piedras Grandes 3 mines ot gold; Espina, 1 mine of silver; Ampallao, 2 mines of silver; Concepcion, 1 mine of silver; Bayos, 4 mines of silver; Casa Colorada, 2 mines of silver; Tigre, 7 mines of silver; Aranzazu, 2 mines of silver; Mineral de Maria, 1 mine of gold; Mineral del Portezuelo de Santa Rosa, 2 mines of gold, and in the district of Rio Blanco, 7 mines; but it is not stated what class of mineral existed there.

From the year 1830 to 1871, the number of mines registered, and matters referring thereto, amounted to 679; and from 1871 to 1878 the number had increased to 975. In 1884, the number decreased to 298, increasing again in 1885, to 316, and in 1888, to 318.

The company "Anglo-Aleman", appears to have been the first formal European enterprise to work the silver mines of the Cerro Negro in the Famatina mountains; but the works which

had been commenced were interrupted by the civil wars of Quiroga, and, by his orders, the agent of the company was murdered somewhere between 1827-8.

Another company was attempted to be formed in Chile, in 1847, for working the silver mines of the Cerro Negro; but the undertaking failed.

It appears that the ever to be remembered Rozas, prohibited foreigners from working mines, and for that reason, the brothers Herdmann abandoned copper and nickel mines which they discovered somewhere about 1848-49 at a place called Jagüe, near to Vinchina, in the province of La Rioja. Afterwards, these mines passed into the hands of Mr. Ramon Elizalde who worked them in 1851; but they were again possessed by the Herdmanns in 1852-53. It appears that the mineral assayed 50 °/₀ of nickel.

The German brothers Hermann, also exploited other mines containing copper, gold and silver in the same locality, and they erected a small establishment of fundition for the reduction of the minerals which continued in work until 1855, and it has been stated that the works were closed because sufficient profit was not obtained.

About 1868-69, Mr. E. Huniken, a German, from Chile, constructed furnaces of fundition in a place called Escaleras, situated near to the village of Famatina, and he proposed to found mineral obtained from the mines situated in the Mejicana district; but, in 1870, this establishment was closed, passing into the hands of Mr. Galvan in 1871, and after he had expended a considerable sum, the works were finally abandoned. The same party erected similar works of fundition in the Valley situated a little to the North of Villa Argentina, or Chilecito; but a short time afterwards these were also abandoned.

In about 1863-64, Mr. Massori, in connection with a

Mr. Plaza, erected a small establishment of fundition at Sañagasta, situated at about 12 miles soutward of Villa Argentina with an object of reducing galena, and after experimenting for sometime the works were finally closed.

Mr. Ricardo Valdez, noted for creating numerous law-suits, commenced his mining adventures in the province of La Rioja in about 1860, and he obtained various associates until, somewhere about 1877. Formerly, he had obtained a large sum from Mr. William Treloar, who could not procure its return, consequenty after a long law-suit the copper, gold, and silver mine "Upulungos", together with establishment of fundition situated at Tilimuque were transferred to Mr. Treloar.

Previous to this transferrence one of the associates of Mr. Valdez i. e., Colonel Campos, worked the mine "Upulungos" reducing the copper mineral at Tilimuque, Colonel Lucas Cordoba, the present governor of the province of Tucuman, was the general agent of Colonel Campos in about 1884-85; the management in this case was good and considerable benefit was obtained, but for the reasons already assigned, the mines and establishment of reduction passed into the hands of Mr. William Treloar, who has continued to exploit the mines and reduce the copper ores at the establishment referred to until quite recently.

Mr. Treloar, is one of the principal pioneers in reviving mining operations in the districts under consideration.

Another energetic firm in devoloping the silver mines in the Cerro Negro, especially in the Caldera districts and reducing the mineral to a metallic condition, was headed by the late Mr. Almonacid. He possessed a small establishment for founding the silver ores at San Miguel, situate close to the town of Villa Argentina. The whole of these works were continued with good results for several years, and Mr. Almonacid had as associates Messrs. Parchappe, Galup, Lanus & Son;

but, in about 1882-83, the silver mines had been worked to a considerable extent requiring extra capital to conduct other and deeper exploring galleries; but at that period capital was not easily obtained in Buenos Aires, consequently the result was that the mines were not so productive, and this finally led to a collapse of the company.

An additional cause for the closing of the mines and fundition was an exagerated and too costly system of management.

Immediately afterwards, the mines of silver alluded to with the establishment of fundition were tranferred to Messrs. Lanus and Company. This new firm employed Mr. John Pemberthy, a well known English mining engineer in South America, to manage the silver mines in the Cerro Negro and Caldera districts, and he drove a deep gallery to intersect the mineral veins and was fortunate in discovering a very large and rich native silver deposit; however, sometime afterwards Mr. Pemberthy resigned his position, and the silver mines and establishment soon relapsed into an unprofitable condition.

In about 1880, a French Engineer, Mr. Fonert, examined the silver mines in the Cerro Negro district of the Famatina range of mountains, and selected a series of mines upon which he raised capital in France. The nominal capital of the company was 4,000,000 of francs, or £ 160,000, but only £ 40,000 were called up. This company commenced upon an extensive scale devoting more time and money to the erection of an Establishment of Fundition and comfortable surroundings, than to the construction of roads and a thorough and systematic development of the mines. The works were continued for some years, but it does not appear that the French company received sufficient benefit to enable them to continue the system which had been initiated.

Since that period, the establishment of reduction, which was

situated at Nonogasta, has been kept going at intervals, the mineral reduced being purchased from various miners.

After the late Mr. Fonert separated himself from the French Company, previously referred to, he erected a small establishment of reduction at the Corrales, near to the town of Famatina, with the object of reducing the copper minerals which could be obtained from the Mejicana district.

In about 1881, a Company was formed in Buenos Aires called "Esperanza", with a capital of 60,000 dollars, gold, with the object of working the copper, silver and gold mine called "Mellizas", in the Mejicana district; but considering that the administration and technical direction was entrusted to a man without any mining experience, the whole of the capital was expended without yielding beneficial results.

Mr. William Treloar, the gentleman previously referred to, formerly obtained good results from the exploitation of his rich silver mines situated in the Cerro Negro. His gold, copper and silver mines, situated in the district called "El Oro" have a good history, having been exploited by ancient miners, probably the Indians, and the Jesuits. When examining these mines, in about 1883-4, the writer found a curiously formed ancient hammer, which he presented to the School of Mines in Paris.

Doctor Cullen, the well known and long established advocate in Buenos Aires, was associated with Mr. Treloar, in these gold mines, and towards the end of 1886 their agents formed a company in London, with a capital of £ 200,000; but, before determining the nature of the mineral to be treated the company purchased stamping machinery, expending £ 30,000 thereon.

Unfortunately, as is generally the case, the London directors sent out a manager who knew nothing of the language of the country, and consequently, had great difficulty in treating with and managing the miners. No formal workings of consequen-

ce seem to have been carried on at the mines and for this reason the machinery was never installed, and after two years expenditure of the capital in doing nothing that brought profit the company determined to wind up their affairs in the El Oro district. Messrs. Cullen and Treloar, were not satisfied with the management and decision of the company and very honorably offered some gold mines belonging to Doctor Cullen, situated in the province of San Juan, to which we shall have occasion to refer later on.

It gives the writer the greatest pleasure to note that the family of the Davilas has, from time to time, done much to forward the mining industry in the province of La Rioja, devoting both time and fortune to this object, and their advice and assistance was always accepted with the greatest confidence. The influence thus initiated many years since has been continued by the present representative of the family, i. e., Doctor Adolfo Davila, one of the Hon. members of Congress and chief editor of "La Prensa" of Buenos Aires.

Other names worthy of recording and connected with mining operations in past times were those of Mr. Samuel Garcia, father of the present Senator of the Nation, Mr. Antonio Garcia, Messrs. Gomez, Achaval, Lozano, and Carlos Angel.

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In reference to the mines situated in the Cerro de Capillitas, province of Catamarca, it is generally acknowledged that Messrs. Malbran and Espeche, were the first, in modern times, to restore and direct particular attention to this important mineral district in about 1851-53. It also appears that the former owners of the celebrated copper mine "Restauradora", were Messrs. Thomas Porto, Cristino Figaroa, Cristobal de la Madrid, Rios and others. The copper ore extracted from this mine was smelted in a small establishment installed in a place called Vis-Vis.

The late Mr. Carranza, in association with Mr. Marcelino Augier and Mr. Samuel Lafone, late father of the present Mr. Samuel Lafone Quevedo, exploited the copper mines of "Santa Clara" and "La Argentina", about 1853, and they reduced the mineral in a small establishment which they installed at a place called Ampayango, situated at a distance of about 6 miles from Punta de Balastro. This establishment consisted of two small furnaces of reduction.

During the period indicated, it is stated that the late Mr. Samuel Lafone offered 4,500 ounces of gold to Marcelino Augier for the copper mine "Santa Clara"; but the latter refused to sell his property.

After Mr. Carranza retired from the company previously referred to, the late Mr. Lafone, purchased the copper mine "Restauradora" for, as it is said, the sum of £ 20,000.

Immediately after the purchase, he installed an establishment of reduction, near to Santa Maria, situated at a considerable distance from the mines, but consequent upon the want of a practical knowledge of metallurgy and sufficient supply of wood of a size large enough to produce the necessary heat for the reduction operations, no beneficial result was obtained and the site was abandoned.

It is believed that the present Mr. Samuel Lafone Quevedo commenced to take an active part in the administration of his father's mine previous to or about 1861: he was, and has remained a man of great energy and enterprise, consequently he obtained proper mining Engineering advice which resulted in the installation of a new establishment at a place called Pilciaco, situated at a distance of about 16 miles South of the town of *El Fuerte de Andalgala.*

When the writer examined the mines referred to, in 1884, he had the opportunity of inspecting the old accounts which recorded that a large quantity of copper ore had been ex-

tracted and sent to the establishment at Santa Maria, and to that at Pilciao.

The mines referred to and the establishment of fundition have been continued by Messrs. Lafone & Co. until quite recently.

No site could have been better selected, at that time than that of Pilciaco, for an establishment of fundition, for the reason that there exists an immense forest of algarroba trees of large size in the vicinity. This in the best wood in the Republic for the purpose of reducing minerals.

Another group of mines existing in the Cerros of Capillitas, were exploited by the late Mr. Adolfo Carranza, and he reduced the mineral in his establishment of fundition called "Constancia" and situated at Pipanaco. Copper mineral seems to have been founded in that establishment from 1856 to 1886.

Mr. Augier, previously referred to, exploited his mines "Santa Clara", "Grande" and "La Argentina" to a considerable extent disposing of the mineral to the establishment previously referred to.

Various other mines were exploited for a short period of time in this part of the province of Catamarca, but it is not known what benefit was derived.

§

In the province of San Juan mining has been carried on for a considerable period of time, but checked at, intervals, by various circumstances. The mines in the Tontal district received considerable attention in 1860, but practical mining operations did not commence there earlier than 1862. At the end of 1865, an Establishment of reduction was installed at Hilario, being a very favourable situation for metallurgical operations on account of the great abundance of wood and water existing in the neighbourhood. It is reported that the capital raised for carrying on mining and metallurgical operations at that place

amounted to £ 64,000, and that for a period of 10 months, during which the reduction operations lasted, 1,400 tons of mineral were treated yielding 94,560 ounces of silver, the value of which was estimated at £ 23,000. It has also been reported, that apart from the quantity of silver noted, a great deal of silver was taken to Chile and other Establishments in the province of San Juan.

It is also stated on good authority, that the Establishment of reduction and mines referred to, were closed in 1866. This seems to have been occasioned by some internal revolution which rendered transport between the mines and the establishment of reduction impossible. The civil wars which arose from time to time completely paralized the mining industry in this province, and its evil effects were also felt in no small degree in the surrounding provinces.

It also appears that a small establishment of Amalgamation for the extraction of silver was installed in a place called *Sovocayense*, in 1869, costing the modest sum of £ 2,500.

No more than 8 tons of mineral per month were treated producing about 2,800 ounces of silver per annum, and estimated to be worth £ 850.

There were, also, furnaces of reduction constructed on the river Castaño prior to 1868, and during that year, only 130 tons of mineral were treated producing 12,530 ounces of silver which were valued at £ 3,000. The whole of these works only cost £ 3,900.

The methods employed for the extraction of the metal were very antiquated, consequently a good deal of the silver was lost. It would appear that the original capital was too small to enable the works to be carried on, and some inundations which occurred damaged the work and hastened the undertakings to a close.

It is believed that the mineral district of Castaño was, as it is

termed, rediscoveded in 1863, and that in 1869 other attempts to install establishments of reduction were made upon a small scale: but in this case, also, the capital was too small to bring about any remunerative result, consequently after a few experiments mining and reduction operations ceased.

The mines which exist in the mining district of *Gualilan*, are believed to have been exploited by the Spaniards after they conquered the Indian tribes.

In 1750, a mule driver, named Juan Suarez, rediscovered an ancient rich gold mine in the Gualilan district, also Vicente Oros endeavoured to take the water out of an ancient gold mine in the same district, and on one accasion had the good fortune to do so and actually extracted 12 tons of mineral which yielded at the rate of 5 ounces of gold per ton; but considering that he employed very rude modes for taking out the water, he found that it was impossible to keep the mine dry and ultimately, was obliged to abandon it. Apparently these important rich gold mines have never been rediscovered since the time of Oros and Suarez.

It is also reported on good authority, that another ancient mine situated in this district, called "Misnala", was opened on one occasion and a limited quantity of mineral extracted from it which yielded 96 ounces of gold and 4,900 ounces of silver.

A group of 16 or more mines formed the Gualilan mining district proper, and in 1867, an English Company was formed by the influence, it is said, of Mr. T. Ignacio Rickard. The capital appears to have amounted to £ 75,000. Old fashioned Cornish machinery was installed at the mines for surface operations, and as the mines were opened, pumps were placed in them to drain the water. It would appear that the modes of amalgamation were very antiquated as well as imperfect, consequently the whole of the metal contained was not extracted. The management was also inferior and great earlessness

was observed, and this induced frequent robberies of the amalgam. However, the mines were carried on for a considerable time until the supply of wood within a reasonable distance was exhausted. This would seem to be one of the principal reasons why the mines were abandoned.

Very recently these mines attracted considerable attention, and a syndicate was formed in Buenos Aires to develope the Gualilan gold and silver mines, and after obtaining various mining experts from the states and from England to examine the properties and indicate where explorations should be made, the mines were given up before any company had been formed in Europe to exploit them in a proper and formal manner. It would appear that the syndicate carried on their operations in the neighbourhood of the old workings which had been made by the English Company in 1867. It is unfortunate that no mining operations were carried on in the Northern portions of the group, where the old rich gold mines are believed to exist.

The mineral district of *Salado*, received considerable atention in 1844, and the brothers Fonseca, installed an establishment of fundition which consisted of two high furnaces, as they were termed, and it is reported that in a single month they produced 1,330 ounces of gold.

The total cost of the installation was £ 1,000, but for some reason or another their operations seem to have decreased, for, in the year 1869, they employed no more than 14 workmen.

An establishment of reduction, called "La Argentina", was installed in the *Huerta* mining district prior to 1860-5; but in that year the reports demonstrated that during the first six months of 1868, 71 tons of mineral were reduced, yielding 21,157 ozs. of silver, and from that date until 1869, the company reduced 1,011 tons of mineral yielding 226,700 ozs. of silver, which were estimated at that period to be worth £ 32,275.

The establishment consisted of five small high furnaces, a refining and two reverbatory furnaces. The mineral treated appears to have contained copper, zinc, antimony and arsenic.

There is no precise evidence to show why the ehstablishment and mines were abandoned, neither is it known how much capital was expended upon the works; and it is highly probable that the total capital of the company was, as usual, too small, and that at that period it was difficult to augment it.

The other elements contained in the galena treated may also have offerred difficulties, which together with the high cost of transport may have assisted in the closure of the works.

Various other companies have been formed from time to time to work the galena and gold mines which exist in this province but, at present, space cannot be devoted to a general history of these.

When treating of La Rioja, a company was mentioned as having undertook to exploit the mines of *El Oro* there, and that Messrs. Cullen and Treloar were associated with the company, they being owners of the mines in question. After failure, owing to bad management, Doctor Cullen, very generously offered the gold mines which he possessed in the province of San Juan to the Company.

The London Company accepted the offer and sent their manager from La Rioja to San Juan to exploit the mines and he erected part of the machinery which had been previously purchased for *El Oro* mines. A considerable sum was expended in driving adits to intersect the gold-bearing veins, and the installation of machinery seems to have been made without a previous study of the effect due to the annual inundations, the result being that the whole of the machinery was carried away and lost in the river San Juan, as well as all the mineral which had been extracted and not treated. The company then ceased their mining operations in this locality.

Since that period, a French Engineer, M. Sabatier, has obtained possession of the same gold mines and has treated the mineral by the *cyanide process* with considerable benefit.

Much attention has been given to certain deposits of Lignite, by some called coal, which exists in this province. As far back as the time of M. Richard, those deposits of carbon were noticed, and even before his time they were known to exist.

In 1871, the late Mr. D. F. S. Klappenbach, a worthy and honourable mining pioneer, directed considerable attention to these deposits of carbon which were then believed to exist over large areas. The lignite he extracted assayed 46 °/₀ of fixed carbon, 10 °/₀ of ash with 43·90 °/₀ of volatile materials. The beds of lignite were thin ranging from 10 to 35 centimetres in thickness, and the lignite obtained from some of these was much more inferior than the assay shown above. It is scarcely necessary to note that Mr. Klappenbach realised no profit from his undertaking.

The experience thus gained of the Lignite beds of the province of San Juan, was not sufficient to prevent others from making themselves believe that good coal deposits existed in the locality indicated: consequently, in 1897, a French adventurer, Juan Cruvellier, commenced mining operations at a place which he called Las Himanas. He sunk too small pits, 2 ½ metres in diameter each, and at a distance of 70 metres from each other, and it is believed that a depth of 55 metres was reached. The thickness of the lignite beds was from 10 to 20 centimetres, and from an analisis which was made in the assay office of the National Government Mint, the lignite gave 43·15 °/₀ of fixed carbon, 30·80 °/₀ of volatile matter and 21·55 °/₀ of ash. The writer took a large sample of this lignite to the Exhibition of Chicago in 1893; but it was considered to be too inferior to receive any attention from the jury of awards. After all these circumstances were made public, it is surprising as

well as extreemely absurd that sensible people can still be found to spend money and time upon studies in this locality.

§

As was the case in various other provinces, the ancient gold mines in the province of San Luis were worked by the Indians, and there is evidence to prove that afterwards the gold mines were exploited by the Spaniards under the orders of the king of Spain, as has been previously noted.

The old copper mine, "Biroca" or "Viraorca", was discovered by Joseph Pinto and Jose Cortes Funes, in 1860, but they only exploited the mines for two months. The mineral which was extracted from this mine assayed from 27 to 40 % of copper, and also yielded 4 ozs. of silver per cwt. At this period the mineral had to be transported by means of bullock-carts to Buenos Aires.

In 1865, the same mines were possessed by a Mr. David Livingstone, who was associated with Joseph Martin Ortiz as capitalist. Livingstone possessed an estate not far distant, and it is believed that at the time he exploited the mines, his company possessed a capital of 80,000 dollars. The pits for the extraction of the mineral were made upon the inclination of the veins and did not exceed 20 metres in depth, and from the bottom of these inclined pits, declining gallieries were made to a further depth of 50 metres. Operations were carried on upon a small scale, for there were no more than 39 workmen employed. The mineral extracted from the mine was taken to a place called *Las Tapias*, known at the present time by the name of Florida, which seems to be a small hamlet situated at a distance of about 2½ leagues from the mine "Viraorca", and 5½ leagues in a North Easterly direction from the town of San Luis.

The mineral was reduced to copper bars in a small furnace

of fundition at Florida. The copper bars contained gold and silver. It appears that on one occasion, the copper mine was inundated, and there not being sufficient means at hand to keep it dry, it was abandoned, and the associates of Mr. Livingstone, seemed to have commenced their work with spirit; but the difficulties which finally arose cost the loss of 60,000 dollars.

The mineral from the mine "Viraorca", was said to be difficult to smelt, due, probably to an imperfect flux or some other metallurgical defect.

Mr. Livingstone was an enterprising man, and rather than abandone mining altogether, he installed a new furnace of fundition constructed upon an improved principle, and commenced to reduce the mineral which he obtained from mines which seem to have been under exploitation in the *Carolina* district.

The class of minerals which he attempted to reduce consisted of iron pyrites containing gold, and also copper ores which he bought from another mine called "Santa Barbara", as also, from other mines. He expended £ 5,000 in his last experiments; but he did not realise sufficient benefit to induce him to continue the works.

The gold mines of *La Carolina,* were worked at distinct times and by different persons, and as was the general custom at that period, the undertaking was abandoned for the want of sufficient capital, cheaper transport, and better mining and metallurgical knowledge.

In more modern times these mines have again been caused to attract considerable attention, for, in the year 1893, a company was formed in London, with a capital of £ 50,000, for the exploitation of these gold mines. The capital of the company was afterwards augmented to £ 100,000.

In the chapter more particularly devoted to the mines and mining in this province, other data will be given and also, a re-

ference to some of the companies which have been engaged in developing the mining industry there.

§

There does not exist in the possession of the writer much reliable information upon ancient and modern mining operations in the province of Tucuman.

The provinces of Salta and Jujuy have a better history, and in the chapters reserved for a description of the mines and mining in those northern regions, we shall endeavour to give such data as may represent them fairly.

§

From all the circumstances brought under our notice, we were under the belief that the second period of modern mining in the province of Cordoba may be fixed in the years 1820 or 1823; but as have occurred in the more western provinces the civil wars which raged about the years 1829, 1830 and 1840, interrupted and injured the mining industry of this province to an alarming extent.

History indicates that a miner from the province of La Rioja discovered the first silver (galena) mine, near to a place then called *Pocho,* but it has been ascertained that other similar mines had been known to exist long anterior to this period.

So few were the expert miners obtainable to work the mines of this province, it was found necessary to introduce miners and others experienced in the art of amalgamation to work in the mines and extract the silver from its ores.

It would appear that an establishment for amalgamation was first installed at a place called *San Roque,* situated at a distance of about 24 miles in a western direction from the city of Cordoba. Although the mountains of this province are not very high, still the occassional heavy rains swell the rivers cau-

sing inundations, and on one occasion the greater part of the machinery and a large quantity of mineral were carried away at that place by the floods. For these, and other reasons, the establishment referred to was abandoned, and another for the reduction of the mineral was afterwards installed at a place called San Francisco, situated at some considerable distance from San Roque.

Although the Chilian and Bolivian miners who had been employed in the mines of this province did not remain for any length of time, still, by their means, other important veins of mineral were discovered, and this circumstance was of importance at that period as proving the existence of extensive mineral districts in the province. The methods adopted for the extraction of the silver from its ores were exceedingly rude and primitive, having been introduced from Bolivia and Chili, still considerable benefit was, it is said, obtained.

Unfortunately, the miners of that period suffered great loss in their mining undertakings due to the civil war movements of that notorious Quiroga, who, with the *gauchos* from Los *Llanos* of La Rioja and other places overran the country. That lawless man caused the complete destruction of the amalgamating establishment which had been in operation at San Francisco and, consequently, mining operations were retarded for a considerable period.

When peace was restored, a third establishment for the treatment of the minerals was installed at a place called *Faninga*, to the west of the mountains; but the mining and metallurgical operations were directed by inexperienced persons, and, for this reason, a large part of the silver was lost. It does not appear that much profit was derived.

In the year 1834, some foreign miners erected a small establishment for the reduction of mineral, at a place called *Ojo de Agua*, but they did not appear to have understood the

nature of the mineral to be treated, which together with their inferior processes resulted in the loss of half the silver contained in the ores, consequently, the mines and establishment were abandoned.

Another establishment also existed in 1834, at a place called *Cacapiche,* the owners of which had not previously been in any way connected with mining or metallurgy, and although the methods adopted were antiquated, still the company, obtained better results than had been secured up to that time.

Another establishment was installed in 1837, and at this period, the methods employed to extract the metal were superior consequently better results were obtained than by the older processes employed. However, grave changes supervened, which together with the death of one of the proprietors, and other unfortunate circumstances led to a termination of the mining and metallurgical operations, which had been undertaken and which were considered to offer advantages and success.

In the year 1842, furnaces of fundition were also erected at *Faninga;* but the results which were obtained were not superior to these which had been realised at *Ojo de Agua.*

This company exploited the mines upon a limited scale, and with small capital the benefit derived must therefore, have been comparatively small.

Other furnaces of fundition were constructed in 1854, which, together with the others which existed were considered to be more than sufficient to reduce all the mineral which was then extracted from the mines, and for this reason it was believed that a competing company was unnecessary, and had the effect of destroying the efforts of the smaller companies which had formerly entered upon similar operations with limited capital. It was believed that the company of *Ojo de Agua* carried on their operations with a capital of about 6000 dollars, and others with much less.

It is recorded that from 1837 to 1867, about 300 tons of mineral per year were treated in the establishment at *Taninga* or *Faninga*, yielding 216,000 ozs. of silver, which were reduced from about 9,000 tons of mineral which had been extracted from the mines during a considerable period of time. The value was estimated at £ 50,000 or at the rate of £ 1,666 per annum; but as previously noticed nearly the 1/4 part of the silver was lost, due to a bad system of reduction and administration. Also, the cost of labour and material were excessive, so that the benefit obtained could not have been large.

In the year 1869, there existed only three establishments for the reduction of mineral in this province i. e., *Trapiche de Mercedes* (Taninga), *Ojo de Agua* and *Santa Barbara.*

The first as previously noted was situated at some 75 miles west of the city of Cordoba, or in the valley of *Salsacasto* and consisted of two high furnaces, as they were then called, two furnaces for calcination and one furnace to refine the silver.

From the older processes, which at first had been carried on their remained a large quantity of scoria or slag calculated at 4,000 tons, and when again treated yielded 20 °/₀ of lead and 15 oz. of silver per ton, proving the imperfect methods of extraction practiced in former periods.

In the year 1868, about 220 tons of mineral were reduced, without including the scoria, and there were obtained from this quantity about 22,000 ozs. of silver, estimated at that time to have a value of £ 5,600.

The reduction works situated at about 21 miles north west from *Taninga* or *Faninga*, consisted only of a single furnace of reduction, one for calcination and a third for refining the silver. The motive power which existed at the works consisted of a water wheel 25 feet in diameter. Higher up on the same current of water another water-wheel 20 ft. in diameter was installed, and this gave motion to a small stamping mill, with

three heads of stamps for pulverizing the mineral before it was calcined. The scoria which had accumulated at this place amounted to 5,000 tons, and an assay of it yielded 20 °/₀ of lead and a small quantity of silver.

The establishment for the reduction of mineral at Santa Barbara, was situated at a distance of about 27 miles to the west of *Ojo de Agua*, and it consisted of three high furnaces, one for calcination and a third for refining. This establishment was fitted with all other necessary apparatus.

In the year 1868, from a produce of 84 tons of crude mineral 13,940 ozs. of silver were obtained, estimated at that period at the value of £ 3,700.

It seems that these works were installed at about 1832, but they were afterwards abandoned for several years. In about 1854, they were improved, and reduction operations were again commenced; but, on this occasion, the lesson which should have been learnt from the employment of inadequate capital and the consequent failure which had so frequently taken place, had no effect, for we find that the capital of this new company amounted to no more than £ 2,000.

Other smaller amalgamating works were constructed in 1869 near to a place called *Candelaria*, with the object of extracting gold which existed in quartz veins at that place. Similar establishments were, also, constructed near to a mine called "Tauro", situated at a distance of about 36 miles from the town of Cordoba. It is believed that the then owner was the late Mr. Samuel Lafone, and it is reported that he expended a considerable sum upon the works.

Since the periods indicated, various small companies have been formed to work mines and extract the metal from the ores. A special note may be taken of one of these, in this place, which attempted to exploit the gold mines of the *Candelaria* district. This company was formed in Buenos Aires,

and its capital was augmented at various times. Mining and reducing operations were carried on for several years, and after expending a large sum the scheme was finally abandoned.

The quartz at the surface, and for some little distance in depth, existed in a spongy condition, i. e., it was full of holes lined with red oxide of iron and in these holes native gold appeared in abundance, but these bunches of good ore were isolated and did not continue in depth. When the whole vein was treated, the quantity of gold derived was only a few grammes for ton. We shall have occasion to speak in a more particular manner of the mines in this province in a chapter set apart for it.

CHAPTER III

Different classes of Economic Minerals Existing in the Province of La Rioja.

Including Assays of Minerals Existing in this and Other Provinces.

It has been considered convenient to commence with a description of the classes of mineral found in this part of the Republic, because they are more varied than in the other provinces: besides it occupies a central position and is generally considered to be one of the most important mining regions.

1. Native Silver.—This class is frequently presented in a filiform state varying in size and distributed throughout the veins containing other classes of silver mineral. Native silver is also found in different fantastic and other floriated forms as, also, in masses.

When first extracted from the mine, it has a white shining or metallic luster. It is frequently dotted about in the body of the vein, and, at other times, the whole thickness of the vein contains native silver and would assay from 60 to 65 %. Such rich deposits of silver sometimes run for a distance of various metres in the direction of the strike of the vein and also to a considerable distance to the rise and to the dip of the exploring galliery. These deposits of native silver may occur at several points or places and at variable distances one from another in the direction of the strike of the vein.

Many such cases have occurred in various silver mines in the districts of Cerro Negro, Calderas, Tigre, etc. Generally, however, native silver is mixed with other classes and, consequently, assays would be variable.

2. SULPHIDE OF SILVER. — Also termed *Silver Glance,* or *Vitrious Silver.* When it occurs in a pure condition it is malleable with a metallic luster and dark lead colour. Its primitive form is cubical, but it also occurs in octahedron and rhombic forms. It cuts like lead and has a black streak. It would assay, when pure, as much as 87.60 °/₀ of silver and 12.40 °/₀ of sulphur, with variations when other elements, such as iron, enter into the composition. This class of silver, in a pure condition is, however, found in small quantities in this country, and is valued more for collections than for commercial purposes.

The writer has not seen in the mining districts under notice, samples weighing more than 5 or 6 ozs. each, but when, as a member of the Jury of Awards at the Chicago Exhibition of 1893, he examined several large samples of sulphide of silver which were exhibited before the Jury, as a curiosity, each of which would have weighed several pounds.

In the Silver mines of this province, sulphide of silver is found in a poorer form. The body of the silver veins generally consist of quartz which is blackened with patches of sulphide of silver, dotted about in all directions closer or farther apart as the case may be. A common or average mixture of the entire contents of such veins of mineral would yield from 0·001 to 2 °/₀ of silver, with all possible variations between these limits.

3. KERARGYRITE, *Chloride or Horn Silver.* — The physical aspect of this mineral is peculiar, and it occurs in small crystallized cubes, as, also, in various massive forms. It has a waxy appearance, and is easily scratched with the nail. Its colour is that of a pearl-grey, but much exposure to the light gives it a dark brown colour with a light greenish tinge.

It is malleable, and the cut of a knife leaves a white and shining streak. Its composition is proto-chloride of silver and, when pure, would assay 75 °/₀ of silver and 25 °/₀ of chlorine, with some variations.

In a pure condition, this mineral is not found in large quantities, but is sometimes largely mixed with other silver ores. When it is present in quantity, it augments the percentage of the metallic yield to a considerable extent.

4. PYRARGYRITE.—Has been considered by some mineralogists as a synonyme of dark red silver ores, but, by others, it has been divided into two varieties i. e., *Dark red silver ore, and light red silver ore.* Apart from the difference indicated by the streak in each, an analysis would determine one from the other. This mineral sometimes occurs in clusters of prismatic crystals as, also, in variously formed masses mixed with other silver mineral. When first extracted from the mine its colour is dark red, but after much exposure to the light it is oxidized and presents a colour between lead grey and iron black. The dark variety has a metallic lustre, and is easily cut with the knife: the streak left is dark red. Its composition, in a pure state, is about 61.50 °/₀ of silver, 20.9 °/₀ of antimony and 17.60 °/₀ of sulphur with slight variations. This mineral has, sometimes, been confounded with Cinnabar, owing to the similarity of colour; but there is a great difference in physical appearance, besides the specific gravity of the former is greater than that of the latter.

Another important difference is, that *pyrargyrite* yields a silver button before the Blowpipe instead of volatilizing as is the case with cinnabar. The occurrence of this mineral in pure cristals is rare in the mining districts under notice.

5. PROUSTITE, *or Light red Ruby Silver ore.*—This mineral occurs in isolated and group crystals. Its primitive form is an obtuse rhombohedron, and its colour, when first extracted from

the mine, is crimson red or cochineal. It is semi-transparent, and when cut with a knife leaves a streak of cochineal-red. When broken it presents an uneaven fracture.

Its composition is 65·20 °/₀ of silver, 19 °/₀ sulphur and 14·90 °/₀ of arsenic, with 0·90 °/₀ of antimony.

However, various assays would present some variation.

It will be observed that in this variety of mineral, the greater part of the antimony occurring in pyrargyrite has been replaced by arsenic. Pure crystals of proustite are rare, but this mineral occurs in masses mixed with other silver ores.

6. MIARGYRITE.—Some mineralogists do not include this mineral as a variety of the foregoing ones; but in some respects it would seem to be allied to them.

The primary form of this mineral is that of an obligue Rhombic prism; crystals of it also occur in a thick tabular form. Its lustre may be considered to be between metallic and adamantine. It is opaque; but when cut into thin plates, or setions, and brought into contact with a strong transmitted light, its colour is of a blood red, and its streak dark cherry red. It is soft and readily yields to the knife.

The composition of a good sample may be taken as follows: silver 36·10 °/₀, antimony 39·20 °/₀, sulphur 22·00 °/₀ iron 1·60 °/₀ and copper 1·04 °/₀. In this mineral there is a large quantity of antimony and the arsenic in proustite is replaced by iron and copper. This mineral is generally mixed with other varieties of silver ores, and, in that condition, it is also easy to be recognised.

STEPHANITE.—"The primary form of this mineral is a right rhombic prism, occurring in short prismatic or in thick tabular crystals", as also massive. It has a dark lead grey colour, almost iron black, metallic, shining, and is soft and brittle. Its principal composition consist of sulphide of silver, antimony, etc.; as in the following analysis, Silver 68·54 °/₀, Antimony 14·68 °/₀, Sulphur 16·42 °/₀ and Copper 0.64 °/₀.

It does not occur in a pure condition in this Republic, but is disseminated with other classes of silver ores. The writer possesses a few samples of this mineral in a nearly pure condition, said to have been extracted from the mine called "Peregrina" situated in the Cerro Negro.

ARGENTARSENICKEL.—This is a very rare mineral in this country, and was not known to exist prior to 1877. In that year, the writer had occasion to conduct numerous assays of the mineral collections which he exhibited at the exhibition of Paris in 1889, in representation of the Argentine Government, and on that occasion the elements which were determined proved the mineral to possess a new combination.

The Jury of awards in the Exhibition of Paris, at the date mentioned, including the President the late celebrated M. Daubrée, and the mineralogist the late M. Fouchs, affirmed that this mineral had a new combination of elements totally different to other classes, then known.

An analysis of it was made in the Argentine Government Mint, in Buenos Aires, by the eminent chemist and metallurgist, Doctor J. J. J. Kyle, and, therefore, it is authorative. The analysis is as follows:

N.º 1

Silver	32·22 %
Zinc	6·60 "
Arsenic	23·46 "
Nickel	12·58 "
Sulphur	13·04 "
Iron	8·40 "
Manganese	0·79 "
Insoluble matters	2·60 "
Oxygen and loss	0·31 "
	100·00

The mineral known as *Gersdorffite* contains some of the above elements, but silver is not present as will be seen in the following analysis:

N.º 2

Arsenic	39·40 °/₀
Sulphur	16·91 "
Nickel	28·62 "
Iron	12·19 "
Cobalt	2·88 "
	100·00

This mineral is sometimes called nickel-glance and is described as *cubical pyritohedral.* It occurs in octhedrondons, sometimes with the faces of the pentagonal dodecahedron and cubo-octahedron. Colour tin white inclined to lead grey, often with a grey or greyish-black tarnish. Lustre metallic. Streak, greyish-black. Fracture, uneaven".

Another variety of this mineral is *Amoibite,* occurring in small octahedrons of a pale steel-grey colour. Its analysis is:

N.º 3

Arsenic	45·34 °/₀
Nickel	37·34 "
Sulphur	14·00 "
Iron	2·50 "
Lead	0·82 "
Cobalt	traces "
	100·00

In neither of these varietes is silver found, but N.º 3 contains lead which is absent in N.ºs 1 and 2, a sufficient difference to qualify it for a new name.

The mineral known as *Kupfernickel*, or copper nickel, generally contains the following elements which are extracted from *Bristow's* mineralogy:

N.º 4

Nickel	33·67	%
Iron	1·43	"
Antimony	28·37	"
Arsenic	33·67	"
Sulphur	2·86	"
	100·00	

It is described as "hexagonal in form, rarely occurring crystallized, but most commonly massive and of a grey or blackish tarnish, by exposure. Lustre metallic; streak pale brownish black".

The mineral we have described as *Argentarsenickel* does not tarnish by exposure, but, those parts which are red, continue to maintain that colour, the streak is also red whilst that of *copper nickel* is pale brownish black; besides, in other respects, it differs materially from the analysis Nos. 2, 3 and 4.

When a mineral contains some elements similar to other minerals, with an additional metallic element, a divergence of opinion has existed as to whether it should receive a new name or not. However, after considering the question, the best authorites have decided in the affirmative. The writer is, therefore, of opinion that he is justified in fixing upon the name *Argentarsenickel* for this mineral, taking it in the order of the higher percentages of the principal elements in the analysis.

This mineral is not known to exist but in a single mine i. e., "La Blanca", situated in the Calderas mining district. The mine has, however, been closed for a considerable period, and the

lower workings flooded, so that it is impossible to obtain additional samples.

In the years 1881-82, a very rich sample of silver mineral came into the possession of the writer from the mine "Santa Teresa", situated in the mining district of Cerro Negro. It was massive, with numerous wires of native silver running through it in all directions. Its colour was a darkish-grey, with a green tinge. It was analysed on the 10th. of June 1882, and yielded the following results:

N.º 5

Silver	26 85 %
Gold	traces
Iron	13·80 "
Zinc	3·60 "
Nickel	3·20 "
Cobalt	1·30 "
Lead	0·55 "
Antimony	0·30 "
Arsenic	9.70 "
Oxide of Manganese	13·80 "
Copper	traces
Sulphur	2·30 "
Alumina	0·80 "
Magnesia	1·20 "
Lime	0·20 "
Chlorine	traces
Siliceous insoluble matter	2.50 "
Water, Oxygen and Loss	20·10 "
	100·00

There would seem to be some analogy between the analysis Nos. 1 and 5; but the latter contains elements not found in Nos. 1, 2, 3 and 4.

The writer believes that the existence of nickel and cobalt

was not known to exist in the silver mineral of the Cerro Negro district previous to the date cited.

However, as far back as 1879, nickel was known to exist at a place called *Jagüe*, in the Departament of Vinchina, in the province of La Rioja. At the date referred to, the late Doctor Puiggari, made an analysis of the nickel mineral, and he was led to believe that it was obtained from one of the mining districts of Famatina; but the late Doctor Brackenbusch, professor of mineralogy in the University of Cordoba, stated that nickel did not exist at that period in the regions named, and, further, that the sample of nickel mineral analysed by Doctor Puiggari came from Jagüe. The following are the elements which were contained in the sample of nickel referred to.

N.º 6

Nickel	40·9
Arsenic	33·4
Sequioxide of Uranium	6·3
Protoxide of Iron	5·4
Calcium	8·9
Silicon (oxide)	3·2
Sulphur	0·9
Water	0·4
Loss	0·6
	100·0

The two first elements in the analysis N.º 6, are similar to the corresponding ones in N.º 4, and, therefore, may be considered to be allied with copper-nickel; but as the other elements are dissimilar to those contained in the analysis N.ºs 1 and 5, it seems to be a proof that this mineral was derived from the nickel mines in Jagüe, as previously noticed.

BROMIDE OF SILVER.—This mineral is found cubical, in cubo-octahedrons. When it is pure and newly extracted from the

mine, its colour is a bright yellow, with patches of a greenish tinge. Pure samples would assay from 42·6 °/₀ to 42.44 °/₀ of bromide, and from 57·4 to 57·56 °/₀ of silver. It is, however, generally mixed with other classes of silver ores, especially those containing a good deal of oxide of iron. It is generally found near to the surface. The oxide of iron, locally called *Paco*, is frequently strongly impregnated with a mixture of Native, Sulphide, Bromide and Iodide of Silver. Sometimes the silver contained in the oxide of iron is in the form of chloride, and would not be apparent; but if submitted to the flame of the blow-pipe, the Silver immediately appears in a native form in white patches or spots depending upon the richness of the sample. In the absence of a blow-pipe apparatus, the native miners calcine the mineral, throwing it afterwards into cold water, which has the same effect, and in this way they prove whether the *paco* mineral is worth exploiting or not.

POLYBACITE.—This mineral occurs in short tabular six sided prisms, striated parallel to their base. Colour and streak iron-black when thin slices are made and submitted to transmitted light, it has a cherry-red colour. Lustre metallic with an uneven fracture.

Its composition is *Sulphantimonite of Silver*, in which part of the silver is replaced by copper and part of the antimony by arsenic. The writer has not seen pure samples of this mineral from the mines of this country and, consequently, possesses no analysis of it; but, Bristow, gives the following analysis as representing a pure sample:

N.º 7

Silver.	64·29 °/₀
Sulphur	17·04 "
Copper	9·93 "
Antimony	5·09 "
Arsenic	3·74 "
Iron	0·06 "
	100·15

Naturally, samples of this mineral differ in purity and, consequently, analysis of such would differ from the above.

This mineral occurs in the mines of this country mixed in varying proportions with other classes of silver ore.

The classes of silver ore previously described, are those which have generally been recognised as existing in the silver mines in the various mining districts in the Famatina mountains.

Doubtless some other classes exist mixed with the ordinary silver ores; but, as these have not been determined in a pure condition, no analysis of them can be given. Many of the veins of silver ore in the various districts referred to, occur at the surface in a ferruginous condition, locally called *paco*, but it diminishes in depth, and is replaced by compact quartz and other elements and, as previously noted, it is in this class of mineral where the Native and Sulphide of Silver occur in the greatest abundance.

The classes of silver, previously described, are distributed in the mineral veins in varying proportions: the chlorides, bromides and iodides occur as, previously noticed, more in the ferruginous masses than in the quartz. The Native and Ruby Silver ores occur more in the quartz than in the ferruginous masses. Either one or the other of the classes named

could exist together or separately, but the indications presented by a single sample, no matter how rich, is no proof of the richness of the average produce of a vein. The value of a mine of this class must, therefore, depend upon the proportion of each class of mineral produced per year.

Some of the samples of silver ore selected from the National Museum of minerals belonging to the National Government Offices of Mines and Geology, sent to the Sant Louis exhibition, would assay as follows:

N.º 8

Native Silver from . .	0·05	%	to	60·15	%
Ruby Silver " . .	0·24	"	"	65·20	"
Sulphide " . .	3·60	"	"	60·10	"
Native and sulphides .	0·05	"	"	20·30	"
Bromides	0·75	"	"	5·20	"
Chloro-bromides . .	0·90	"	"	3·60	"

The average produce which has been obtained from the silver mines in the districts referred to, will be noted in another chapter.

COPPER ORES

The principal copper mines of this province, exist in a mountainous district, called *La Mejicana.* The veins of mineral, as also the mines, are numerous, and the copper ores are of various classes, generally mixed with a considerable quantity of gold and silver. The general class of mineral is:

ENARGITE, described as occurring in a rhombic form with an Iron-black colour and metalic lustre. The cut of a knife leaves a black streak. This mineral is very brittle, and the fracture is uneaven. A pure sample of it would analyze

N.º 9

Copper	47·20 °/₀
Arsenic	17·59 "
Antimony	1·61 "
Iron	0·56 "
Zinc	0·22 "
Sulphur	32·22 "
Silver	0·01 "
	99·41

When this class of mineral was first discovered in this country, much attention was directed to its contents and determination. When it is free from deliterious elements and other classes of copper, the following analysis fairly represents it.

	N.º 10	N.º 11	N.º 12
Copper	46·99 °/₀	47·10 °/₀	48·10 °/₀
Arsenic	14·38 "	16·90 "	17·04 "
Antimony	2·24 "	1·54 "	1·89 "
Iron	2·50 "	1·76 "	1·19 "
Lead	3·20 "	0·99 "	0.50 "
Sulphur	29·20 "	30.86 "	31·00 "
Residue and loss	1·49 "	0·85 "	0·28 "
	100·00	100·00	100·00

The samples of mineral, employed in the above analysis, were obtained from the celebrated mine "*Upulungos*". Generally, this class of mineral is mixed with various others, such as green and blue carbonates, chalcopyrite, spots of sulphate, etc.

Not many years since, a new combination of copper elements was discovered, the principal being designated:

FAMATINITA. — It occurs massive, with a peculiar purplish

tinge, and, up to the present, it has not been discovered in any other part of the Argentine Republic. It is accompanied with enargite and the other classes of copper ores indicated above, and, consequently, it is difficult to procure samples in a pure condition.

The contents of this mineral were not only determined in this country, but also in Germany. We may, therefore, accept the determination with the greatest confidence.

It has been communicated to me that the person who originally discovered this mineral was the late Emilio Huniken, a celebrated chemist and metallurgist who was for many years associated with the mines of this province.

From some of the best samples of this mineral procurable, the following analysis were made:

	N.º 13	N.º 14	N.º 15
Copper	43·84 %	44·04 %	43·87 %
Arsenic	4·01 "	3·49 "	2·93 "
Antimony	23·10 "	22.92 "	23·65 "
Sulphur	29·05 "	29·55 "	28·55 "
	100·00	100·00	100·00

The principal difference existing between *Enargite* and *Famatinita*, is that the former contains less antimony and arsenic, with iron and lead, than the latter. Some of the finest samples of enargite the world ever saw will be exhibited in the Argentine Section of Mining and Metallurgy in the Exhibition of San Louis, 1904.

COVELLINE.—The primitive form of this mineral is hexagonal, with a colour representing indigo-blue, and a sub-metallic lustre; its streak is a shining black, and when in a pure condition its elements, as determined by analysis, are represented as follows:

N.º 16

Copper	65·20 %
Sulphur	31·50 "
Iron	2·10 "
Insoluble materials and loss	1·20 "
	100·00

This class of copper is, however, mixed in some of the copper veins of this district with others in considerable quantities.

ERUBESCITE.—The primitive form of this mineral is cubical, and is found in a crystalized and massive condition. Its general colour is purplish, and, when newly fractured, the colour would approach to a copper red, but it is soon oxydised by exposure. It has a metallic lustre and, when in a pure condition, the following elements would represent it.

N.º 17

Copper	56·76 %
Sulphur	25·24 "
Iron	14·84 "
Insoluble matter and loss	3·16 "
	100·00

Erubescite is sometimes associated with *Bornite* and *Phillipsite*.

CYANOSITE.—This is a sulphate of copper occurring in "stalatitic, reniform and amorphous masses" as, also, incrustations.

It has a dark sky-blue colour, varying in shade. Sometimes the stalactitic parts appear as a whitish blue. It has a vitreous lustre, is brittle and is uneaven in fracture and dissolves in water. A good sample would yield:

	N.º 18	N.º 19
Oxide of copper.	30·10 %	to 31·20 %
Sulphuric acid	32·50 "	" 33·05 "
Water and Loss	37·40 "	" 35·75 "
	100·00	100·00

This mineral occurs in the mines of *Los Bayos* district, but is mixed to a large extent with Chalcopyrite and sometimes Enargite, and consequently, an analysis of it would differ from those given above. It also carries gold and silver, which gives to it an essential difference from pure samples of sulphate of copper.

EUCARITE.—This mineral is described by some of the older mineralogists as occurring "massive, and in thin superficial black films, staining the calcareous rocks in which it is contained". The colour is between silver white and lead-grey with a metallic lustre and granular texture. It is rather soft, and when cut with a knife leaves a gray shining streak. When fractured, it has a fine silvery grain.

The composition of this mineral is a *selenide of silver* and *copper*, and, therefore, the above description of its physical appearance should include a dark greenish colour in parts. It is fairly represented by the following analysis:

N.º 20

Selenium	26·00 %
Copper.	23·05 "
Silver.	38·93 "
Gangue.	8·99 "
Carbonic acid and Loss . . .	3·13 "
	100·00

This is considered to be a rare mineral, having been found but in few places, and in small quantities.

However, within the last few years, a large deposit of it was discovered at *Humango*, near to the town of VINCHINA. Some persons have designated it as *Humangite*. Analysis of several samples gave the following results:

N.º 21

Selenium	31·53	%
Silver	42·90	"
Copper	25.47	"
	99·90	

This mineral contains more silver, selenium and copper than N.º 20.

Other samples of mineral obtained from the same mine yield the following results:

N.º 22

Copper	54·45	%
Silver	0·55	"
Selenium	45·00	"
	100·00	

The copper and selenium in this assay is augmented and the silver diminished; and, for this reason, the mineral was considered to be a *selenide of copper*.

The mine in question only yielded a few tons of this class of mineral, the greater part of which was sold to the reduction establishments, and the remainder distributed between the museums and collectionists. Some samples found their way to Germany; but none to France or England, I believe.

The vein of mineral appears to have pinched out in the Hu-

mango mine; but one would suppose that if work had been continued in the deep and on the strike of the vein, other deposits may have been discovered.

COPPER-NICKEL.—Occurs in a hexagonal form, crystals of it, however, are rare. It is more frequently found in a massive condition and has a copper-red colour; but, after much exposure, it tarnishes. Generally it has a metallic lustre, and when cut with the point of a knife, it leaves a dark brownish streak. It is brittle and the fracture is imperfect, fine grained and uneven.

Its composition is usually considered to be a di-arsenide of nickel. It is usually mixed with other minerals giving a variety in the analysis as is exhibited in the preceeding analysis N.º 7, which was made from mineral of this country.

GALENA.—Generally occurs crystallized in a cubic octahedron, and in various other combinations of these, with planes and other figures, as also, in amorphous masses with lamellar structure.

Sometimes, argentiferous lead presents a fine granular form, with a lead grey colour; but in some varieties it changes to a dark bluish colour: it has a metallic lustre and its composition is *protosulphide* of lead; but it frequently contains other metallic elements.

The following is a characteristic example of analysis of this mineral:

N.º 23

Silver	0·325	%
Lead	80·700	"
Antimony	3·307	"
Iron	1·377	"
Copper	0·440	"
Zinc	0·024	"
Sulphur	12·840	"
Insoluble material water and loss	0·987	"
	100·000	

This class of mineral is found in considerable quantities in the province under consideration, as, also in other mineral provinces; but in general the crystals are large, and, consequently, contain but a comparatively small amount of silver. There are, however, some varieties in the mines of the province of Cordoba with a fine steel or granular structure which yield a considerable amount of silver.

A vein of mineral exists in Rio Blanco, in the province of La Rioja, of the class under consideration, samples of which have yielded the following results:

N.º 24

Lead	39·00	%
Silver	1·40	"
Zinc	0·60	"
Copper	3·50	"
Iron	2·00	"
Antimony	32·00	"
Sulphur	20·40	"
Insoluble residue loss and water	1·10	"
	100·00	

Galena has been employed to a considerable extent in some of the establishments of reduction as a fundent to reduce the more refractory minerals, and an average determination from 20 tons of this class of mineral gave the following results:

N.º 25

Silver	0·142	°/₀
Lead	32·000	"
Oxide of Iron	27·000	"
Oxide of manganese	2·500	"
Sulphuric acid	4·000	"
Carbonic acid	3·000	"
Silica	14·000	"
Sulphur	6·000	"
Water	8·000	"
Oxygen	3·000	"
Loss, etc.	0·358	"
	100·000	

An analysis made by the lafe Mr. E. Huniken, from mineral obtained from mines in the district of Los Llanos, gave the following results:

N.º 26

Silver	0·036	°/₀
Gold	0 005	"
Lead	40·000	"
Copper	30·000	"

Considering that this only amounted to 70·041 °/₀ there existed 29·969 °/₀ of other elements not described.

Other samples of mineral obtained from the mines of the same district gave varying results as in the three following tables, Nos. 27, 28, and 29.

N.º 27

Copper	8·000 °/₀	14·000 °/₀	15·000 °/₀	17·000 °/₀
Gold	0·029 "	0·002 "	0·004 "	0·036 "
Silver	—	0·045 "	0·030 "	—

N.º 28

Copper	12·000 °/₀	13·000 °/₀	16·000 °/₀	17·000 °/₀	30·000 °/₀
Gold .	—	—	0.002 "	—	—
Silver .	0·120 "	0·014 "	0·015 "	0·013 "	0·013 "
Lead .	—	—	—	5·000 "	—

N.º 29

Copper . .	3·000 °/₀	5·000 °/₀	5·000 °/₀	5·000 °/₀	9·000 °/₀
Gold . . .	0·004 "	0·003 "	0·002 "	—	0·003 "
Silver . .	0·045 "	0·045 "	0·420 "	0·057 "	0·179 "
Lead . . .	8·000 "	16.000 "	19·000 "	9·000 "	—

Samples of mineral obtained from mines existing in the Valley Hermoso, in the district of Vinchina, assayed as follows:

N.º 30

Copper	Silver	Gold	Lead
40·5 °/₀	0·672 °/₀	0·0002 °/₀	4 °/₀
22·4 "	0·122 "	0·0001 "	8 "

Description of Minerals in Other Parts of the Republic with Their Analysis.

PROVINCE OF CATAMARCA.

The copper-ores extracted from the mines are, with the exception of large bodies of *enargite, famatinita* and *sulphate* of copper, similar in class to those already described as existing in La Rioja.

The following analysis represents copper ores extracted

from some of the mines of the Hoyada, a mineral district situated in the Northern part of the province.

N.º 31

Copper	42·399 %
Silver	2·370 "
Lead	1·161 "
Zinc	traces "
Sulphate of zinc	8·037 "
Iron	10·010 "
Sulphur	13·241 "
Insoluble matter	15·100 "
Combined water, oxigen, carbonic acid and loss	7·682
	100·000

Another sample of copper ore, obtained from the mines of the same district, yielded the following analysis:

N.º 32

Copper	39·844 %
Silver	0·677 "
Lead	0·389 "
Iron	2·100 "
Sulphur	9·462 "
Insoluble matter	44·000 "
Oxygen, carbonic acid and loss	3·528 "
	100·000

Analysis of the copper ores obtained from the celebrated mine "Panchita", also in the same district, gave the following results:

N° 33

Copper	40.962 °/₀
Silver	1·020 "
Iron	2·520 "
Sulphur	8·364 "
Insoluble matter	39.800 "
Oxygen, combined water and carbonic acid	7·334 "
	100·000

When the writer visited this district, he found that the greater part of the mines has been closed on account of the great cost of transport; but some of them had been very productive.

Samples were obtained and the following, analysis exhibits the elements as obtained from an average produce of one of the mines:

N.° 34

Copper	10·00 °/₀
Silver	10·67 "
Iron	13·65 "
Lead	8·55 "
Arsenic	2·08 "
Antimony	0·14 "
Zinc	21·24 "
Sulphur	13·81 "
Insoluble matter	4·01 "
Carbonic acid	5·00 "
Water in combination	3·08 "
Oxygen (calculated)	7·67 "
Loss	0·10 "
	100·00

A very peculiar sample of mineral was given to the writer when visiting the town of Chilecito some years since, and

he was informed that it was obtained by a miner of great experience from a vein of mineral which he had discovered in the Northern part of the province of Catamarca i. e., the Hoyada or near to it. When, therefore, the writer made expeditions into that province, inquiries were made and the miners residing in all the mining districts consulted, but no one knew of the existence of the vein of mineral in question, and when the sample of mineral was exhibited to them they possessed no knowledge of its class, confessing that it was new to them. It has been considered that the sample refered to and in the possession of the writer is the only one of its class known to exist in this Republic. If is fine grained, of blackish colour, without metallic luster and has great resistence to fracture. It has been assayed on several occasions.

The following analysis, made by Doctor Kyle, of the National Government Mint, represents its elements:

N.º 35

Base of quartz	70·210 %
Silver	0·568 "
Gold	0·032 "
Copper	11·490 "
Zinc	0·540 "
Iron.	0·600 "
Lead	traces
Antimony.	1·320 "
Arsenic	7·137 "
Sulphur	8·103 "
	100·000

This being considered to be a rare mineral, the writer ventured to give it the name of *Hoyadite*.

The gold produce is at the rate of 10·45 ounces, and that of silver 183·55 ounces per ton with 11·49 % of copper:

N.º 36

Per Cent	Per Cent	Per Cent	Per Cent
70·15	17·30	35·79	9·20
30·60	17·20	31·10	4·45
25·04	21·60	25·95	5·30
20·31	4·10	35·50	12·20
25·40	23·90	35·39	4·20
5·00	13·60	7·20	25·30
10·46	10·70	10·20	25·40
10·22	12·30	9·25	2·75
22·70	31·20	33·29	3·50
12·25	2·00	65·35	6·50
21·64	19·20	15·20	30·25
14·38	8·40	15·29	10·00
12·15	28·30	38·25	10·35
15·30	10·90	25·20	21·34
9·11	3·20	11·35	3·26
30 09	16·90	6·35	8·10
30·42	27·70	4·37	2·50
16·30	33·45	38·49	3·10
10·15	14·70	23·25	32·40
12·62	2·10	48·36	15·20
35·25	13·95	10·15	5·00
18·15	3·55	31·95	6·25
45·10	2·00	25·34	0·25
12·40	2·25	4·20	11·25
65·32	13·25	10·00	0·25
10·65	11·22	11·19	5·25
28·25	28·35	20·00	35·50
30·12	35·25	18·97	11·25
33·80	15·92	0·25	9·45
40·54	11·45	1·50	4·25
13·50	7·25	3·50	10·25
15·75	15·95	6·25	1·25
16·25	8·25	24·25	22·34
6·20	7·24	4·00	1·38
50·15	35·25	11·25	15·25
12·30	42·29	9·30	3·25
14·10	27·37	12·20	6·44
14·30	12·10	30·50	48·29
10·80	10·25	10·35	36·42

N.º 37

Per Cent	Per Cent	Per Cent	Per Cent
3·20	32·45	40·00	14·35
2·40	7·25	13·95	30·25
10·20	45·35	30·00	14·26
11·10	31·15	6·50	7·35
14·20	5·00	25·30	10·75
15·40	65·93	0·50	25·30
31·42	29·45	31·55	6.20

A large number of assays were made of various samples of native silver from which those above, N.º 36, and 37 were selected as representing the poover as also the richer classes.

N.º 38

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
12·24	6·25	68·20	0·35	58·29	1·50
22·40	12·32	37·29	0·25	48·67	14·00
5·20	15·25	24·36	5·84	6·28	46·00
12·24	10·45	31·42	5·25	18·24	4·30
35·26	0·52	0·25	16·24	41·64	10·20
28·60	54·00	5·25	32·56	45·65	6·25
31·42	55·29	32·94	38·29	18·40	67·49
37·97	15·39	8·46	40·60	8·73	3·29
15·00	25·35	23·46	0·01	34·25	23·25
48·25	25·36	0·01	2·35	7·19	2·00
22·26	35·29	5·26	12·24	3·24	4·00
47·97	6·10	0·25	7·84	4·40	36·42

The above assays, contained in the table N.º 38, represent the percentage yield of silver contained in various samples of mineral of the class of Bromide, Sulplide, Native Silver and some others not determined.

These samples were collected by the writer during one of his exploring visits made to the district in which the mines exist and from which the samples were extracted.

The analysis were made in the laboratory of the National Government Department of Mines and Geology; but the other elements determined to complete each analysis are not given because it would be a repetition of what has already been demonstrated; besides space could not be devoted to it.

However, ample details have been given in former pages to which the reader is referred for such particulars.

N.° 39

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
8·91	4·36	0·84	5·07	7·88	2·04
7·00	4·836	4·23	9·83	1·44	1·20
2·25	4·16	4·15	9·08	6·12	1·38
6·64	3·20	3·36	3·23	8·66	7·32
3·40	18·33	0·25	3·28	1·36	5·48
3·20	3·96	4·20	1·25	2·10	7·08
15·47	7·20	4·88	12·10	4·74	4·36
5·76	11·25	4·70	5·16	0·75	0·25
1·25	5·48	4·62	4·20	5·38	2·64
2·44	1·74	3·04	2·14	0·24	3·04
1·56	2·82	9·64	3·25	1·95	1·55
4·76	2·25	3·20	2·00	0·65	2·50
6·20	17·35	3·50	1·25	7·35	4·20
0·25	1·20	3·50	3·53	4·24	2·50
3·00	1·50	3·10	0·25	1·00	0·25
3·50	4·20	6·35	5·55	5·24	3·47
18·57	5·09	—	—	—	—

The percentage yield of silver contained in the above table, N.° 39, was selected from a long list of analysis.

The average of those given may be obtained from the sum of each horizontal line taken across the columns.

These determinations were obtained from samples of sulphide of silver.

Naturally, it is easy to understand that each sample of mineral treated, would have its richer and poorers parts and hence there is a great difference in the assays.

N.° 40

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
8·00	10·00	8·00	7·00	6·00	10·12
13·45	7·25	3·60	71·25	26·24	70·25
69·45	39·64	5·25	—	—	—

The above table, N.° 40, contains a selection of assay determinations of various samples of sulphide of silver ores, the richest being noted and, as previously indicated, the average percentage of each horizontal line taken across the columns may be found by a simple process.

N.° 41

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
13·24	9·34	6·25	7·27	3·20	2·20
8·10	12·65	2·25	5·65	4·00	1·24
6·10	5·14	0·25	3·25	3·20	9·35
8·94	3·21	1·24	5·65	12·30	9·61
10·65	5·28	3·10	6·24	11·07	5·20
13·24	2·24	4·25	8·00	8·20	6·30

It is necessary to observe that in the assay table N.° 41, the richest determinations of this class of mineral i. e., Red or Ruby Silver were not included owing to their exceptional richness and rareness of occurrence.

N.° 42

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
10·00	5·00	10·20	4·00	60·00	71·35
45·20	6·40	—	—	—	—

As previously noted the occurrence of this class of mineral i. e., chloride of silver ore, in a pure condition is rare, consequently, but a few determinations could be made.

N°. 43

Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
0·32	17·47	6·00	8·00	25·35	8·04
6·26	3·56	11·42	25·78	18·88	4·12
15·40	5·88	15·90	3·72	30·00	12·24
6·64	2·00	0·50	1·60	2·40	3·11
1·20	4·20	4·13	0·09	1 00	1·50
4·36	7·27	4·13	4·13	34·68	3·00
2·10	1·45	4·00	0·80	0 35	3·46
0·55	5·00	12·00	5·02	1·50	2·24
35·00	2·20	10·20	12·00	0·55	27·35
5·00	3·20	9·24	12·16	3·00	3·25
3·00	2·18	2·15	1·75	0·99	6·20
5·64	3·24	14·20	1·10	12·29	8·24
4·60	2·20	6·25	2·34	—	—

The mineral (ferruginous) containing Sulphide, Bromide and Native Silver, represented by the assays. N.° 43, exists in greater abundance than the other classes, consequently the determinations more more numerous.

N.° 44

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
40·00	0·250	—	25 000	0·65	0·0053
35·00	3·000	—	18·000	0·50	0·0037
40·00			20·000	0·45	0·0037
63·00	0·800	—	15·000	0·45	0·0074
50·00	0·590	0·0099	12.000	0·20	0·0062
66·00	0·837	0·0160	7·575	—	—
66·00	0·837	0·0160	20·000	0·35	0·0062
66·00	0·837	0·0160	14·000	0·08	0·0074

N.º 45

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
66·00	0·837	0·0160	10·000	0·20	0·0037
65·00	0·837	·01600	22·000	0·55	0·0004
30·00 / 35·00	0·200	—	12·000	0·42	0·0024
			22·000	0·25	0·0049
60·00	1·730	0·0150	25·000	0·54	0·0037
20·00	0·360	0·0240	8·000	0·10	0·0030
24·00	0·560	0·0024	4·000	0·10	0·0024
24·00	0·742	0·0110	12·000	0·20	0·0062
16·00	0·250	0·0031	10·000	0·15	0·0027
71·20	—	—	18·000	0·60	0·0850
30·00 / 40·00	0·350	0·0062	18·000	0·48	0·0220
			5·000	0·10	0·0160
30·00 / 40·00	0·350	0·0062	18·000	0·30	0·0460
			16·000	0·19	0·0270
—	0·200	0·0049	20·000	0·25	0·0037
25·00	0·300	0·0099	20·000	0·30	0·0074
18·00	0·250	0·0049	25·000	0·60	0·0074
35·00	0·250	0·0037	25·000	0·60	0·0074
—	20·600	—	30·000	0·40	0·0024
65·00	0·837	0·0160	25·000	0·40	0·0037
24·24	—	—	30·000	0·15	0·0016
0·757	—	—	15·000	0·20	0·0037
50·000	0·59	0·0090	14·000	0·43	0·0037
66·000	0·837	0·0160	14·000	0·30	0·0037
24·391	—	—	—	0·08	0·0043
14·000	0·28	0·0037	20·000	0·15	0·0037
25·000	0·30	0·0062	18·000	0·70	0·0099
13·483	—	—	18·000	0·70	0·0099
21·967	—	—	24·000	0·27	0·0049
20·000	0·35	0·0049	15·000	0·40	0·0187
5·454	—	—	25·200	0·20	0·0022
14·000	0·40-1·00	0·0049	20·000	0·30	0·0061
30·000	0·60	0·0120	8·000	0·15	0·0062
30·000	0·55	0·0024	30·000	0·45	0·0027
18·000	0·45	0·0074	18·000	0·20	0·0011
8·000	0·20	0·0043	14·000	0·25	0·0027
32·000	0·58	0·0075	15·000	0·30	0·0083
7·570	0·00	—	12·000	0·35	0·0124
5·151	0·00	—	25·000	0·30	0·0066

The table N.º 44 and 45, exhibits various determinations of the copper ores which were obtanied from the mines in the Mejicana district, and is important as representing the yield of copper, gold and silver more particular notice of which will be given when describing the copper mines of that district.

N.º 46

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
21·000	0·15	0·0022	26·058	—	—
5·000	0·20	0·0037	34·996	—	—
18·000	0·25	0·0062	20·452	—	—
12·000	0·50	0·0066	9·847	—	—
20·000	0·65	0·0027	22·725	—	—
10·000	1·00	0·0037	12·120	—	—
12·000	0·65	0·0037	1·212	—	—
20·000	0·42	0·0027	12·120	—	—
20·000	0·30	0·0037	19·089	—	—
25·000	0·40	0·0099	3·957	—	—
48·000	0·35	0.0012	13·539	—	—
13·000	0·40	0·0074	16·872	—	—
13·000	0·40	0·0049	15·101	—	—
16·000	0·40	0·0086	20·205	—	—
8·123	—	—	20·205	—	—
6·457	—	—	70·926	—	—
9·790	—	—	79·280	—	—
3·749	—	—	73·000	—	—
3·939	—	—	90·000	—	—
26·361	—	—	89·000	—	—
33·536	—	—	69·700	—	—
3·666	—	—	69·700	—	—
0·606	—	—	69·390	—	—
0·454	—	—	12·498	—	—
2·878	—	—	34·087	—	—
11·111	—	—	15·622	—	—
26·664	—	—	15·150	—	—
6·211	—	—	26·058	—	—
10·302	—	—	54·078	—	—

The resulting assay as exhibited in Table N.º 46, consist of determinations of the percentage contents of various samples of copper ores, in some of which, the yield of gold and silver were not so constant as those represented in Table N.º 45.

N.º 47

Province	Mine	Copper %	Silver %	Gold %	Observations
Catamarca.....	—	—	0·060	—	
—	—	—	0·070	—	
—	—	—	0·040	—	
—	—	—	0·080	—	
—	—	—	0·084	—	
—	—	—	0·048	—	
—	—	—	0·006	—	
—	—	—	0·216	—	
—	—	—	0·232	—	
—	—	42·18	0·068	—	
—	—	16 26	0·022	—	
—	—	—	0·172	—	
—	—	—	0·168	—	
—	—	—	0·052	—	
—	—	—	0·052	—	
—	—	—	0·012	—	
—	Carmelita.....	11·382	0·038	—	
—	—	—	0·292	—	
—	—	—	0·116	—	
—	—	8·458	0·160	—	
—	Esperanza.....	8·320	0·444	—	
—	Carmelita.....	13·12	0·430	—	
—	Rosario.....	16·90	0·084	—	
—	—	6·72	0·072	—	
—	25 de Mayo ..	4·16	0·024	—	
—	Mina Nueva....	—	0·630	—	
—	Carmelita.....	7·01	0·132	—	
—	Rosario.....	30·72	0·152	—	
—	—	11·84	0·152	—	
—	Esperanza.....	9·10	0·084	—	
—	Carmelita.....	12·71	0·076	—	
—	Mejicana.....	7·65	0·366	—	
—	Pesebrera.....	11·01	0·066	—	
—	Sovabón	7·66	0·055	—	
—	Rosario.....	4·66	0·060	—	
—	—	6·76	0·054	—	
—	—	0·24	0·040	—	
—	Esperanza.....	0·92	0·060	—	
—	—	11·48	0·068	—	
—	Rosario	4·98	0·060	—	
—	Carmelita.....	2·74	0·052	—	
—	—	—	0·044	—	Galena.
—	—	—	0·434	—	
—	—	4·220	0·044	—	Blende.
—	—	7·520	0·076	—	
—	Mejicana.....	—	1·924	—	
—	—	—	0·044	—	
—	Catamarqueña..	—	0·108	—	
—	—	—	0·060	—	
—	Sierra Amarilla.	—	0·067	0·001	
—	—	—	0·070	—	
—	Catamarqueña..	—	0·020	0·0005	

N.º 48

Province	Mine	Copper %	Silver %	Gold %	Observations
Catamarca	Luisa	—	0·060	0·0003	
—	—	—	0·060	0·0005	Galena.
—	Carmelita	8·52	0·348	—	
—	—	6·76	0·028	—	
—	Mejicana	—	0·026	—	
—	Carmelita	23·04	0·152	—	
—	Rosario	8·48	0·052	—	
—	—	3·52	1·572	—	
—	Esperanza	16·96	0·220	—	Galena.
—	—	—	0·052		
—	—	5·225	0·088	—	
—	—	4·95	0·112	—	
—	—	4·95	0·122	—	
—	Rosario	20·52	0·092	—	
—	—	6·48	0·092	—	
—	—	8·10	0·044	—	
—	Esperanza	4·86	0·072	—	
—	Carmelita	7·50	0·276	—	
—	—	6·48	0·204	—	
—	25 de Mayo	—	0·016	—	
—	Rosario	46·44	0·072	—	
—	Carmelita	5·34	0·042	—	
—	—	4·89	0·052	—	
—	—	6·319	0·044	—	
—	Martínez	—	0·222	—	
—	Santillara	—	0·132	—	
—	—	—	0·052	—	
—	Martinez	—	0·092	—	
—	Esperanza	—	0·072	—	
—	Rosario	—	0·122	—	
—	—	—	0·102	—	
—	Esperanza	—	0·072	—	
—	Carmelita	—	0·136	—	
—	—	—	0·092	—	
—	Esperanza	—	0·182	—	
—	—	—	0·152	—	
—	—	—	0·052	—	
—	—	11·90	0·104	0·301	
—	—	12·49	0·112	—	
—	—	11·30	0·132	—	
—	—	16·07	0·072	—	
—	—	22·61	0·144	—	
—	—	11·90	0·064	—	
—	—	12·90	0·072	—	
—	—	16·07	0·072	—	
—	—	11·90	0·072	—	
—	—	16·07	0·112	—	
—	Esperanza	16·66	0·112	—	
—	—	10·71	0·072	—	
—	-	19·11	0·032	—	
—	—	—	0·304	—	
—	—	—	0·352	—	
—	—	—	0·144	—	
—	—	—	0·152	—	
—	—	—	0·260	—	
—	—	—	0·060	—	
—	—	—	0·060	—	
—	—	—	0·072	—	
—	—	—	0·032	—	
—	—	—	0·094	0·004	

N.º 49

Province	Mine	Copper %	Silver %	Gold %	Observations
Catamarca.....	Esperanza.....	—	0·096	—	
—	—	—	0·576	0.0044	
—	—	—	0·064	—	
—	—	—	0·024	—	
—	—	—	0·112	—	
—	—	—	0·164	—	
—	—	63·80	0·072	—	
—	—	—	0·040	—	
—	—	—	0·048	—	
—	—	—	0·072	—	
—	—	—	0·012	—	
—	—	—	0·216	—	
—	—	—	0·096	—	
—	—	32·90	—	—	
—	—	—	0·028	—	
—	—	—	0·040	—	
—	—	—	0·072	—	
—	—	—	0·452		
—	—	—	0·080	—	
—	Romay.....	—	—	—	Iron 54·81 %
—	Carmelita.....	—	0·136	—	
—	—	—	0·322	—	
—	—	—	0·522	—	
—	—	—	0·090	—	
—	—	—	0·066	—	
—	—	—	0·042	—	
—	—	—	0·034	—	
—	—	—	0·050	—	
—	—	—	4·65	0·066	
—	—	12·20	0·098	0·00075	
—	—	4·94	0·066	—	
—	—	12·78	0·098	—	
—	—	12·90	—		
—	—	—	0·100	—	
—	Catamarqueña..	—	—	0·001	
—	Carmelita.....	—	0.66	—	
—	—	60·40	0·30	—	
—	—	48·20	—	—	
—	—	—	0·320	—	
—	—	64·70	0·440	—	
—	—	66·31	0·548	—	
—	—	—	0·472	—	
—	—	48·88	1·052	—	
—	—	36·20	0·582	—	
—	—	58·92	0·312	—	
—	—	67·09	0·224	—	
—	—	64·46	0·352	—	
—	—	69·72	0·392	—	
—	—	56·67	0·352	—	
—	—	58·90	0·52	0·0032	
—	—	61·69	0 487	0·0045	
—	—	60·48	0·501	0·004	
—	—	64·78	0·433	0·007	
—	—	65·06	0·446	0·0065	
—	—	63·00	0·594	0·006	
—	—	62·41	0·587	0·006	
—	—	54·58	0·570	0·005	
—	—	54·33	0·65	0·003	
—	—	50·77	0·536	0·0032	
San Juan.....	—	—	0·867	—	

N.º 50

Province	Mine	Copper %	Silver %	Gold %	Observations
San Juan.....	Carmelita.....	—	1·070	—	
—	—	—	0·536	—	
—	—	—	0·028	—	
—	—	—	0·256	—	
—	—	—	0·016	—	
—	—	9·14	0·042	0·030	
—	—	24·39	0·032	0·012	
—	—	—	2·28	—	
—	—	—	2·27	—	
—	—	44·16	0·176	—	
—	—	—	1·25	—	
—	—	20·72	—	0·006	
—	—	—	0·352	—	
—	—	—	0·036	—	Lead 45·54 %
—	—	—	0·008	—	» 22·77 »
—	—	—	0·032	—	» 46·37 »
—	—	—	0·296	—	
—	—	—	0·362	—	
—	—	—	0·035	—	Lead 16·86 %
—	—	—	0·215	—	
—	—	—	0·046	—	
—	—	—	0·0035	0·0005	Quartz auriferous
—	—	—	—	0·00025	—
—	—	—	—	0·0002	—
—	—	—	—	0·0005	—
—	—	—	—	0·0015	—
—	—	—	—	0·0025	—
—	—	—	—	0·0020	—
—	—	—	—	0·0010	—
—	—	—	—	0·0030	—
—	—	—	—	0·0015	—
—	—	—	—	0·0010	—
—	—	—	—	0·0080	—
—	—	—	—	0·0003	—
—	—	—	—	0·0002	—
—	—	—	—	0·0025	—
—	—	—	—	0·0020	—
—	—	—	—	0·0070	—
—	—	—	—	0·0010	—
—	—	—	0·0220	0·0080	—
—	—	—	0·0055	0·0015	—
—	—	—	0·0195	0·0015	—
—	—	—	0·0830	0·0050	—
—	—	—	0·0120	0·0020	—
—	—	—	0·0160	0·0040	—
—	—	—	0·0020	0·0020	—
—	—	—	0·0175	0·0003	—
—	—	—	0·0090	0·0030	—
—	—	—	0·00375	0·0002	—
—	—	—	0·0040	0·0004	—
—	—	—	0·0920	0·0003	—
—	—	—	0·0080	0·0080	—
—	—	—	0·0020	0·0050	—
—	—	—	0·0080	0·0020	—
—	—	—	0·0080	0·0005	—
—	—	—	0·0080	0·0030	—
—	—	—	0·0080	0·0060	—
—	—	—	0·0050	0·0045	—
—	—	—	0·0610	0·0960	—
—	—	—	0·0040	0·0020	—

N.º 51

Province	Mine	Copper %	Silver %	Gold %	Observations
San Juan.....	Carmelita.....	—	1·254		
—	—	—	0·774	—	
—	—	—	0·446	—	
—	—	—	0·616	—	
Rioja.....	L. Guillaume..	—	0·008	0·007	
	Dn. Diego....				
—	Porteño.....	5·38	0·176	—	
— (Famatina)	—	—	8·115	—	
—	—	—	—	—	
—	—	—	3·508	0·006	
—	—	—	3·794	0·009	
—	—	—	3·858	0·0142	
—	—	—	3·508	0·006	
—	—	—	3·794	0·009	
—	—	—	3·858	0·0142	
—	—	—	6·629	—	
—	—	—	8·696	—	
—	Chilecito.....	—	4·582	—	
Salta.....	Trinidad.....	—	0·040	—	
—	Dolores.	—	0 030	—	
—	Santa Rosa.....	—	0·032	—	
—	—	—	0·032	—	
—	—	33·34	0·160	—	
—	—	29·83	—	—	
—	—	17·90	—	—	
—	—	23·51	—	—	
—	—	91·26	0·02	—	Native copper
—	—	—	0·120	—	
—	—	46·90	—	—	
—	—	49·27	—	—	
—	—	38·15	—	—	
—	—	33·34	0·160	—	
—	—	29·53	—	—	
—	—	17·90	—	—	
—	—	23·51	—	—	
—	—	91·26	0·02	—	Native copper
—	—	—	0·000	0·0006	Auriferous sand
Mendoza.....	Descubridora de San Carlos.	—	—	0·0002	Pyrites
—	—	—	0·08	—	
—	—	—	0·000	0·00875	
—	Chumbicha.....	54·53	0·517	0·005	
San Luis.....	La Carolina....	—	—	0·0069	Auriferous sand
—	—	—	—	0·00195	
—	—	—	0·066	—	
—	—	—	0·038	0·00162	
—	—	—	0·169	—	
—	—	—	0·398	—	
—	—	—	0·238	—	
—	—	—	0·350	—	
—	—	—	0·113	—	
Río Gallegos....	Zanja Pique.....	—	—	0·00245	Auriferous sand
Córdoba.....	—	—	—	0·0004	

The foregoing tables numbers 47, 48, 49, 50, and 51, contain assays made of samples of mineral which were presented by the owners of various mines in the provinces of La Rioja, Catamarca, San Juan, Salta, Mendoza, San Luis, Cordoba, etc. These determinations were made by Doctor J. J. J. Kile, Director of the Laboratry in the National Government Mint. Buenos Aires, and are very important as exhibiting the yield which may be expected to be derived forn those mines.

CHAPTER IV

The Mining Province of La Rioja

This province may, in a general way, be taken to be situated in a north western direction from the City of Buenos Aires. It is bounded to the west by an irregular line which divides it from the eastern limits of the province of San Juan; to the south by the northern limits of the province of Cordoba, to the east by a portion of the province of Tucuman and its remaining eastern and northern limits by the south western and southern boundary of the province of Catamarca.

This province extends over an area of 89,498 square kilometres.

It is known as one of the Andine provinces: the greater portion of its area is covered by lofty mountain regions, divided into a series of chains with intervening narrow, deep and dangerous gorges, difficult of traverse.

One of the most famous chains of mountains in this province, is that known by the old name of Famatina, in various sections of which the mines exist.

The silver mines are generally confined to certain districts, known as Cerro Negro, Calderas, Tigre, and others of lesser importance.

The Silver Mines of Cerro Negro

The mines in this district have, from time to time, attracted much attention, and, for this reason, have become much noted in history, arising from the fact that the "*Santo Domingo*" mine, as we have already noticed in our chapter upon ancient mining, was worked by the Indians who were subject to the Incas. The native Indians did no more than explore on the surface, but such works were continued by the Jesuits, and after their expulsion by their successors the *Aragoneses* who obtained great benefit from this mine, which circumstance caused it to be considered the most celebrated of all the other silver mines in this district.

After the time of the *Aragoneses*, and during the civil wars which raged furiously, this mine was not exploited except for short periods of time, separated by long intervals, because, at that period, there was no security for life or property, and when works were placed in this mine and large quantities of native silver extracted, the mountain robbers generally carried off the whole of it, leaving the miners to escape with their lives as best they could.

The general mode of working consisted in sinking pits upon the slope of the veins of mineral, and there is evidence proving that, at that comparatively early period, enormous quantities of native silver were extracted; but the works were not carried to any considerable depth.

According to the information given to the writer by the owner of this mine, the late Mr. Samuel Garcia, it would appear that in his father's time, silver was extracted from the "*Santo Domingo*" mine to the value of £ 320.000, in a comparatively short space of time; but, due to the frequent robberies,

previously alluded to, not a third part of this amount reached the hands of the owner of the mine. The chief mischief lay with the managers of the mine who gave secret notice to the robbers when a good quantity of silver mineral had been extracted.

When times were more settled, other attempts were made to work this mine upon a small scale, and although a comparatively small amount of capital was employed, the results obtained were excellent: still, the ingrained love of robbery continued, bringing less profit to the owner than was expected, and the operations were again suspended. In this condition the mine continued for many years: the law of mines being satisfied by an annual payment to the provincial government.

This is one of the few mines which has yielded native silver in large masses assaying from 60 °/₀ to 69 °/₀ of metal.

According to the best obtainable information, the thickness of the principal vein of mineral in this mine is from 4 to 5 metres, and the average, or ordinary class of mineral obtained from it has yielded from 6 °/₀ to 9 °/₀ of silver.

The number of mineral veins extisting in this mine is remarkable, for which reason it is considered to be the best in the whole district: works of a formal nature have, however, never been placed in the mine, but if a deep galliery were to be commenced from the side of the mountain and continued through the mine, no doubt the whole of the veins would be intersected and exceedingly large results obtained, and although silver is low in price, still, there is every reason for supposing that great benefit would be derived. However, this is a work which should be undertaken upon a proper system of exploring and administration.

The mine "*David*", is a continuation of "*Santo Domingo*" in a south easterly direction, and one of the principal veins occurring in the former, runs through the latter, and is of the

same nature and quality. This mine has not, however, been exploited in a formal or extensive manner, but sufficient work has been done to prove that the mineral existing in it is sufficiently rich, as has been proved by the mineral extracted from it.

The mine "*Purgatory*", is a continuation of the "*David*", and the same veins of mineral pass through it further towards the south east.

The mine "*Santa Teresa*", is a continuation of the "*Purgatory*", in a south east direction and has been worked to a considerable extent. It has yielded exceedingly rich silver ores, but it was impossible to obtain data referring to the quantity of mineral extracted from it. The writer examined this mine on various occasions and saw the mineral veins in various conditions of richness. Some of the samples of mineral obtained consisted of sulphide, native, and bromide of silver mixed together, and the highest assay determination gave over 26 % of silver.

The analysis number, 5 in chapter N.° 3, was made from mineral extracted from this mine.

It is situated in a valley or gorge at a much lower level than "*Santo Domingo*", consequently, it would be an excellent point from which to continue a galliery, in a north western direction to the "*Santo Domingo*". All the veins could then be intersected and the water drained from the entire group of mines existing in the mountain, which has considerable elevation.

The mine "*Infierno*", is a continuation of the "*Santo Domingo*" to the north west, and is believed to contain the same veins of mineral. Its productive quality has not been tested, although good samples of mineral have been extracted from it.

The mine "*Chañarcillo*", is a continuation of the "*Infierno*",

still further to north west, and as it is a new concession, the mineral veins running through it have not been tested.

The mine "*Transito*", is situated in the neighbourhood of "*Santo Domingo*", and although several veins of mineral exist in it, still the mine has not been worked to any extent.

The mine "*Rosario*", is situated to the west of the southern part of the mine "*Santo Domingo*". It belongs to Mr. Treloar, who has made excavations on the inclination of the vein to a depth of about 20 metres, and he has extracted mineral contaning silver at the rate of from 1·16 °/₀ to 6 °/₀. On another occasion, mineral extracted assayed 8 °/₀ of silver. At that period, however, it was found difficult to continue the workings in the deep on account of the water which infiltrated. The owner of the mine intended to drive a galliery from the side of the mountain to intersect the vein and drain the water.

The mine "*Gloria*", is united with the "*Rosario*", and contains the same veins of mineral, but this mine has not been exploited.

The mine "*Mercedes*", is a continuation to the south east of the mine "*Transito*", and the mine "*San Lorenzo*" is a continuation of the mine "*Mercedes*" in a south eastern direction.

At the surface, the mineral vein passing into this mine was in a ferruginous condition and much native silver has been extracted from it. The samples in the possession of the writer, extracted from this mine, yielded at the rate of 2 °/₀, 6 °/₀, 11 °/₀ and 17 °/₀ of silver. A galliery was commenced from the side of the mountain to intersect the vein of mineral, and when it arrived at a point where it should have intersected the vein, it was found to be absent. It was considered that the vein of mineral had been diplaced by a fault, but no search was made for its rediscovery.

The mine "*Cortadera*", is situated to the north west of the

"*Santo Domingo*", and is celebrated for a continuous supply of rich silver ores which it has yielded for several years, the workings having been carried on upon two veins.

Samples of mineral obtained by the writer from this mine, yielded at the rate of 2 °/₀, 3 °/₀, 7 °/₀, 20 °/₀, 30 °/₀ and 50 °/₀ of silver. There is every reason to believe that one of the veins of mineral existing in the "*Santo Domingo*" passes into the "*Cortadera*".

The mine "*North Santo Domingo*" may, in a certain manner, be considered to be a continuation of the "*Cortadera*". It contains several veins of mineral; but the writer was not able to obtain any samples of mineral from it.

The mine "*Carmona*" is an extension of the "*North Santo Domingo*". The works placed in this mine were not continued more than a few feet in depth; but mineral of an excellent quality was taken out of it.

The mine "*Sofia*", is an extension of the "*Carmona*", but the veins of mineral contained in it have not been tested more than a few metres in depth. It yielded silver ore assaying 1·5 °/₀.

Other mines exist in the neighbourhood of "*Santo Domingo*", but the quality of the veins has not been proved.

The mountain in which the group of mines described is situated, has considerable elevation, and from its highest points, the inclination is very severe, so that there exists the greatest facility for driving a gallery or galleries as previously noted.

On the opposite side of the deep gorge, referred to above, another mountain exists of less altitude, and in it there is another group of silver mines; the most important are "*Puerto*", "*Rosa*", "*Emma*", "*San Pedro del Puerto*" and others.

The mine "*San Pedro del Puerto*", belongs to Mr. W. A. Treloar, and, when the writer visited this district, a considera-

ble quantity of mineral was extracted from it. The veins of mineral in this mine are not so thick as those in "*Santo Domingo*", previously described, according to documents in the possession of the writer referring to the mining operations carried on in this mine, and from its general yield, it appears that the poorest mineral extracted assayed from 3·29 °/₀ to 0·60 °/₀ and 0·90 °/₀ of silver. The second class gave 1·05 °/₀, 1·34 °/₀ and 1·95 °/₀ of silver, and the third, or best class 2·04 °/₀, 6·06 °/₀ and 7·16 °/₀ of silver. There were, however, variations between those limits, because at different zones in the mine, the silver ores were poorer or richer as the case may be. Also, the weight of mineral corresponding to each of the numerous assays, was always variable; the average percentage yield, calculated upon the assay value without taking into account the weight, would therefore give erroneous results. The proportional weight of the richest silver ore annually produced, is much less than that of the poorer classes. However, taking into consideration the total weight of mineral extracted within a given period, the general percentage yield was found to be at the rate of 1·009 °/₀ of silver.

At a later period to that now referred to, poorer ores yielded 0·20 °/₀, 0·58 °/₀ and 0·98 °/₀; those of the middle class 1·02 °/₀, 1·28 °/₀ and 1·90 °/₀; for the third or highest class 2·06 °/₀, 2·28 °/₀ and 8·88 °/₀ of silver.

Nevertheless, for the whole weight of mineral extracted, the percentage yield amounted to 0·99 °/₀. More recently, the yield was at the rate of 1·55 °/₀ of silver. The last recorded note, in the possession of the writer, referring to the production of this mine, shows that the general percentage yield of the whole of the mineral extracted, was at the rate of 2·63 °/₀ of silver.

It is understood that since that period, mineral has been extracted yielding 1·07 °/₀, 1·48 °/₀ and 10·87 °/₀ of silver.

It was proved to the writer, that the benefit obtained from the exploitation of this mine was at the rate of from 45 to 49 °/₀ upon the amount of capital employed.

It has been shown in a previous chapter, that the silver mines in this district are not always in the same condition of yield, and, as the workings in "*San Pedro del Puerto*", had attained a considerable depth and was in its poorest condition when the writer visited it, the assay produce given cannot, therefore, be taken to represent the percentage yield for a series of years.

A great difficulty has been experienced in procuring mining data, which would represent the condition of things over a long period of time, which is much to be regretted.

When the writer examined the mine in question, it had a depth of 80 metres, and he had the pleasure of extracting from the vein of mineral some curiously formed samples of native silver. Since that period, the owner has driven a galliery cutting the vein at a depth of 125 metres from the surface. At that depth, the vein consisted of ferruginous matter and quartz, the former not having a thickness of more than 4 inches, proving the theory previously advanced that it diminishes in thickness with the depth, the quartz increasing.

The mine "*Puerto*" is situated at a short distance in a south west direction from "*San Pedro*", and its exploitation was carried on at intervals by Messrs. Almonacid, Gallup, Lanus and Son. As was customary, the works were made upon the inclination of the vein and reached to a considerable depth. It has yielded a large quantity of mineral, and the samples collected by the writer from this mine, assayed 2 °/₀, 3·5 °/₀, 4·30 °/₀, 6 °/₀ and 21 °/₀ of silver respectively. The books kept by the late Mr. Almonacid show that poorer mineral assayed 0·30 °/₀, 0·54 °/₀ and 0·97 °/₀ of silver, the second class 1.21 °/₀, 1·52 °/₀ and 1·92 °/₀ of silver, and the third, or best, yielded 2·20 °/₀,

3.03 °/₀, 16·69 °/₀ and 20·50 °/₀ of silver. However, calculating the total weight of the mineral extracted from this mine during the whole year, corresponding to the various percentages, the average yield was at the rate of 2·77 °/₀ of silver. More recently the inferior mineral assayed from 0·24 to 0.85 °/₀, the second from 1·08 °/₀ to 2·84 °/₀, and the best, from 3.05 up to 21 and 85 °/₀ of silver, but the average upon the whole weight of mineral corresponding to various assays, was at the rate of a little over 2 °/₀ silver.

The silver mines surrounding the group described, have been exploited with similar results.

Not far from the "*Santo Domingo*", exists a historical mine called "*Vieuda*", but, at the time of the visit of the writer, it was closed and no correct details could be obtained referring to it.

The mine "*Trinidad*" has been located upon the same vein of mineral as the "*Vieuda*", and was found in the same condition.

The mine "*San Andres*", is also believed to be located upon the continuation of the same vein of mineral which passes through the "*Vieuda*", "*Trinidad*" and others, but it is situated on the other side of the gorge which separates the mountains in this neighbourhood. This mine was originally discovered and worked by the Aragoneses, whose adventurous exploits in this Republic have been given in the first chapter. It was worked by means of inclined shafts, and a considerable quantity of rich mineral was extracted from it consisting of chlorides bromides and native silver. Afterwards the veins of mineral were intersected by a galliery driven in from the sides of the mountain.

To the north west of the mine "*San Andres*", another group of silver mines exists, situated in a part of the Cerro Negro, called "Las Gredas". Some of these have been named "*Corazon de Jesus*", "*Star of the East*", etc.

Mineral extracted from these mines assayed from 4 to 25 °/₀ of silver, the class generally consisting of chlorides and sulphides mixed with native silver in varying proportions. Other poorer samples yielded at the rate of 1 °/₀, 2·40 °/₀ and 3.20 °/₀ of silver. The average produce, obtained from a large quantity of mineral, was at the rate of 1·10 °/₀ and 1·15 °/₀ of silver.

Another mine, "*San Nicolas*", was conceded upon the same vein of mineral and has yielded at the rate of from 8 to 50 °/₀ of silver; but there is no evidence to show how much mineral has been extracted, nor the proportion of the classes.

The branch of the Cerro Negro, called "Cienaga", is situated a little distance to the south east from the mine "*San Andres*", and, in this small district, exist a group of silver mines among which may be mentioned "*San Zacarias*", "*Inglesa*", "*Britania*", "*Veta del Sol*", "*Bella Union*", "*Buena Esperanza*", "*Victoria*", etc., but these have not been exploited to any great extent.

Samples of silver ore, extracted from some of them, yielded 1·70 °/₀ and 8 °/₀; but the average product was not known.

The celebrated mine "*Peregrina*", is situated at about 1,000 metres from "*Santo Domingo*", in the direction of south 5°22' west.

In the same locality several other important silver mines exist.

The mine "*Peregrina*" has been worked to a considerable depth and has yielded a large quantity of rich silver ore.

During the first period of its existence, the yield was at the rate of 4.4 °/₀ of silver but, further in the deep, the yield was 1·80 °/₀ of silver. During a period of 10 years, the average percentage yield amounted to 2·4 °/₀ of silver; the richer ores ranging as high as 12 °/₀.

A small vein, or guide of silver ore, containing much native gold, was discovered in this mine, but on extending the workings it was lost, or cut off by a fault.

Without the assistance of an exact geological and topographical map of this region, it is impossible to determine whether the "*Peregrina*" veins of silver ore traverses the mountain "Spiritu Santo", or not, but, from the direction of the last part of the vein worked, it would appear to pass to the east of that mountain.

Other silver and gold mines have been reported to exist in, or near to the gorge in which the *Casa Colorada,* or *Red House,* is situated, one of which has been termed "*Chocoy de los Jesuitas*", but it has never been rediscovered.

Mineral District of the Tigre

According to the best maps of these regions, the central part of this district contains the celebrated silver mine, "*San Miguel*", which is situated to the west of "*Santo Domingo*". In the intermediate distance exist deep gorges and mountain ramifications full of dangerous precipices.

"*San Miguel*" was considered of great importance, and has been exploted with much benefit for many years, and the vein of mineral of the same name has yielded much native silver, almost pure metal, as also ruby silver, the quality of which has been described in a former chapter.

The vein of mineral denominated "*Atahualpa*", also passes into this mine. Samples of the mineral obtained from this mine, in the possession of the writer, assayed at the rate of 1 °/₀, 1·43 °/₀ and 1·70 °/₀. The best quality, 3·38 °/₀, 13·06 and 23·71 °/₀ of silver.

Taking the proportion of the weight of mineral corresponding to various assays, all the mineral extracted from this mine averaged at the rate of 1·48 °/₀ of silver: several other mines in the same neighbourhood have been exploited with various results.

The Mining Districts of the Calderas

These districts are situated in a northern direction from the Cerro Negro, and both of them have the form of a basin surrounded by hills of considerable elevation.

The mule tract leading from the Cerro Negro district to those of Calderas, is narrow, frequently rising and falling at high angles, rendering the journey difficult and tedious.

However, the large quantity of rich silver ore extracted from the mines in these districts has more tham compensated the difficults of access and costly transport.

Various persons have worked these mines since the days of the discoverers, i. a., the *Aragoneses;* but the most important period of exploitation commenced when the mines were purchased, in 1867, by the late Mr. Almonacid.

The average yield of these mines was, at that date, from 1·13 °/₀ to 1·46 °/₀ of silver. These mining districts have an altitude of about 14.000 feet above sea level.

Some years since the writer examined the mines in question, and obtained samples from the mine "*Aragonesa*", of which we have been speaking. In continuing a galliery in this mine, the upper works of which reached about 40 metres in height, an old pit was found, called *los chilenos,* but in reality was one of the pits which had been made by Juan Laita and Juan Chavarria, the *Aragoneses* previously referred to. They worked this mine in 1809-1810.

The mine "*San Pedro*", is of the same kind as the "*Aragonesa*" and was exploited by a galliery driven from the side of the mountain. One of the principal veins was about 2 metres in thickness, with variations. Another vein of silver ore, i. e., "*Transito*", intersects the "*San Pedro*" vein; but is

less in thickness, ranging from 20 centimetres to 1 metre. This mine is believed to be the oldest in the districts, and the rate of yield is variable in percentage.

Samples, extracted by the writer, assayed from 1·20 °/₀ up to 60 °/₀ of silver. It was impossible to discover the proportion of each class of mineral extracted or the quantity, but considering that the mine was worked for many years it must have been considerable.

The mine "*Esperanza*", has been exploited, at intervals for more than 25 years, to a depth of 160 metres from the surface. It contains a very rich vein of silver ore, samples of which have assayed 50 °/₀ of silver with many variations.

It is not a thick vein, and contains a large proportion of blende. The vein of mineral, *Andacollo,* crosses the principal vein in this mine.

The mine "*Blanca*": Due to some obstacle in the mine, it could not be examined when the writer visited this district; but it would seem to contain two or three mineral veins from which rich silver ores had been extracted.

Large samples of ore extracted from this mine, assayed at the rate of 0·21 °/₀ to 4·55 °/₀: the average yield being at the rate of 1·59 °/₀ of silver.

This is the only mine known in the district named to have yielded native silver of a reddish colour, and which the writer afterwards discovered contained nickel—see the analysis N.° 1, chap. III—which was made from samples of silver ores obtained from this mine.

At the present time only a few of the silver mines are being exploited.

At the time of the visit of the writer, there existed 25 mines of silver, 5 of gold and some others containing gold, silver and copper; but neither of these were then under exploitation. From reliable information, it would appear that the

mines of gold, silver and copper referred to were formerly worked and considerable benefit realized.

The Mineral District of El Oro

This district is situated on the south western border of the Cerro Negro, and has an elevation above the sea level of about 10,000 feet. No doubt the name of this district was derived from the fact that the various veins of mineral in it contained gold, or *Oro* as it is termed in Spanish. As previously indicated, the Jesuits exploited some of the mines existing here, and it is highly probable that the veins containing gold were indicated to them by the Indians, who were the first exploiters.

The large excavations made upon the mineral veins, which are still open, prove that these mines were worked to a considerable extent at that remote period. At one time, there were eleven concessions forming a group, divided by a deep gorge, through which, in flood periods, torrents of water rush with great violence. In modern times the ancient works have been continued, and newer ones opened up upon other veins and, according to the best evidence, a considerable quantity of gold was extracted.

Mr. W. A. Treloar, who is a most practical pioneering mining Engineer in the province of La Rioja, examined the gold mines referred to upon several occasions, and was so satisfied with their importance and value that he obtained legal concessions. Afterwards he planted a small stamp mill, other machinery and installations to test the mineral which he had extracted from one of the mines, but the writer does not possess any precise data referring to the quantity of mineral treated, or the benefit received.

However, taking this as a basis, a London Company was

formed to exploit this group of gold mines, but before extracting any mineral from the mines, or determining its quality, purchased machinery, in a haphazard manner, to the value of £ 30,000, without having first determined the class of machinery necessary to treat the mineral. The result was that although the machinery was introduced into the Republic, still, it never reached the "El Oro" mining district.

All that the company did was to clean up some of the old Jesuit working instead of driving a galliery from the foot of the mountain to intersect the whole of the veins in the deep.

Naturally, other galleries could have been made upon the veins themselves, and a continuous supply of mineral obtained until the principal exploring galliery had been finished.

The management was defective, and the direction inadequate, consequently, a large sum of money was expended without corresponding beneficial results. It is scarcely necessary to note that the company abandoned the undertaking.

However, it is quite certain that the company never determined whether the mines were good, bad or indifferent.

Nevertheless, the general opinion of various experienced persons is that the mines possess great value.

The writer examined these mines on one occasion, and the samples he collected assayed at the rate of 1·7 ozs. of gold per ton. A few other samples, however, gave larger results.

The following table of assays (N.º 50) exhibits the results obtained from a large sample of mineral extracted from some of the mines under notice. They were made by the assayers of the Bank of England and English Royal Mint:

N.° 50

CLASSIFICATION	N.° 1	N.° 2	N.° 3	N.° 4
Iron	32·9	38·3	23·2	26·3
Alumina	0·6	1·8	1·2	0·8
Copper	—	0·3	1·6	1·0
Sulphur	2·9	29·2	3·9	5·5
Manganese	—	traces	traces	traces
Silicious insoluble matter	49·8	26·8	59·0	54·2
Gold, silver, water oxigen and loss	13·8	3·6	11·1	12·2
	100·—	100·—	100·—	100·—
	Ozs.	Ozs.	Ozs.	Ozs.
Gold	2·200	1·000	1·100	1·100
Silver	1·250	0·750	1·250	1·250

Doctor Kyle, of the National Government Mint, Buenos Aires, made an assay of samples of this mineral which yielded at the rate of 2·286 ozs. of gold per-ton. Other samples of mineral have assayed at the rate of from 6 to 20 °/₀ of copper, with a fair quantity of gold and silver. This circumstance seems to indicate that, at greater depth, a change of the nature of the veins will occur, introducing a larger percentage of copper: this does not imply that the gold and silver will diminish, but, on the contrary, will increase.

The mineral forming the veins under consideration consist of pyrites of iron, pyrites of copper, other classes of copper, oligistic iron, quartz, baryta, etc.

No doubt these mines will again attract attention and, in the case that a company be formed to exploit them, it is to be hoped that a practical and adequate management will be introduced.

Mining District of the Valle Hermoso

This mining district is situated on the western side of the Famatina range of mountains, in the Department of Vinchina, and mines containing various classes of mineral have been discovered at various times. Some few of the mines have been worked, such, for example, as the copper, silver and gold mines once exploited near to Jagüe: the nickel and copper mines near to the same place, and copper silver and selenium mines at Humango.

About two years since, veins of mineral containing gold, silver, nickel and cobalt, were discovered in this region, i. e., on the western slope of the mountains joined to the elevated range of Famatina. The mine "*Reina Alejandria*" was located upon one of these veins, and workings were commenced under the direction of Mr. O. S. Eriksson.

This gentleman states in his report, that great facilities were offered for the exploitation of the mines by driving short horizontal gallieries from the side of the mountain to intersect the veins of mineral. The workings are not very extensive, but it is considered that the constancy of the body of the ore already discovered would seem to indicate that the mine will be very productive in the depth. The Engineer is sanguine that "some day in the future it will take a place among the resources of mineral wealth of this country". It is also gleaned from the same source, that the ore deposits in question "occur in a large patch of *talcose schist* of several square miles extension, and in contact with the acid igneous rocks of which the main body of the mountain consist". It also appears that several veins of mineral of the same class exist in the neighbourhood, and that at certain points they are well defined at the surface

but as yet no work of importance has been done upon them. The vein of mineral under exploitation bears north 60° west dipping towards the north, and has a thickness of 90 centimetres. In course of working, the vein of mineral was found to be displaced by faults; but its continuation was soon rediscovered.

Considering that the exploitation of this mine has not been conducted on a large scale, and that a considerable amount of time was expended in making an installation and opening up, the yield could not be expected to be large. However, about 300 tons of mineral have been extracted, 150 tons of which were selected ores. The Engineer of the mines has classified the mineral as *Cobaltglance*, mixed with arsenical pyrites in a base of quartz.

Analysis of the first class of mineral gave the following results:

Cobalt, from. . . .	6	to	7	%
Nickel "	0·5	"	2·5	%
Gold "	25	"	30	grammes per ton
Silver "	150	"	300	" " "

And the second, or common ore, gave the following results:

Cobalt, from. . . .	3·0	to	4·5	%
Nickel "	0·10	"	0·8	
Gold "	10	"	20	grammes per ton
Silver "	90	"	180	" " "

It is stated that the distance from this mine, to the nearest railway station's about 120 miles, the mineral being transported by means of pack mules, which is costly and difficult, amounting from £ 8 to £ 9 per ton delivered in Europe.

The Engineer believes, that by concentrating the mineral by simple machinery, it may be brought up to a value of from £ 25 to £ 30 per ton, leaving a large margin of profit.

If such concentrates were to be reduced to regulus, the value per ton would still be augmented.

This region has not been much explored, but if it were in a scientific and practical manner, no doubt many other rich veins of mineral would be discovered.

CHAPTER V

Mines of Copper, Silver and Gold

In the Districts of the MEJICANA, OFIR, AMAPALLO and Others.

The districts enumerated in the above heading, are situated almost contiguous to one another, each of which extends over a considerable area yielding economic minerals of various classes of much importance and value.

The Mining District of The Mejicana

This district is situated at a considerable distance to the north west of the Cerro Negro, and at an altitude of about 18,000 feet above sea level.

Considering that the copper, silver and gold mines of this region have been exploited for many years with great success, the district must be considered as one of the most important copper regions in the province of La Rioja.

The highest point in the Mejicana district is the top of the mountain called *Espina,* which has been estimated at 18,813 feet above sea level, but the writer has reason to believe that its true height would be as much at 18,970 feet.

The writer visited this district on several occasions, but the wind was so strong that he found it impossible to ascend this mountain. Its height was not, therefore, measured. This mountain has a general bearing to the north east and consists of various ramifications with lower levels.

The Mejicana mountains proper, in which the principal mines of copper exist, lie to the north east of the ramifications of the *Espino*. The rocks in this district belong to the inferior part of the great *Silurían* period, and as may be supposed intrusive dykes of porphry, trachyte, diorite, etc. exist.

Numerous mineral veins exist consisting of quartz, ferruginous matter mixed with metalliferous elements of different classes, and in varying proportions. One of these was discovered near to the highest point of the *Espino*, and after some examination, an ancient gold mine was discovered upon the vein referred to. This mine was reopened and yielded considerable benefit.

In the Mejicana mountains proper and ramifications, there are a large number of copper veins crossing one another in various directions. In general, with the exception of the large masses of *Enargite*, the copper mineral is of the same class as is found in other parts of the world, with the difference that in this district, the copper ores contain a large percentage of gold and silver which, however, varies in different veins as also in the same vein of mineral. This circumstance would appear to depend more or less upon the presence of cross veins. There also exist mineral veins yielding silver without copper or gold, and others containing copper without gold or silver, as also other containing only gold.

At the commencement, when mining was in its infancy, some of the mines were worked from the surface to a small depth for the gold and silver they contained; but, at certain zones below the surface, the general character of the mi-

neral changed, introducing other economic metalliferous elements, with the gold, such as copper in various forms, pyrites of iron, antimony, arsenic, etc., and, consequently, at that period, great difficulty was encountered in the extraction of the gold and silver by the rude modes of amalgamation then employed. For this reason, and the civil wars which arose to impede progress, the mines were abandoned for a considerable time. Afterwards, the mines were conceded to others who, for similar reasons, abandoned their enterprise.

After a considerable time had elapsed and peace was restored, other attempts were made to exploit the mines and transport the mineral to Chile, but the costs were too heavy to allow of any benefit causing a complete stagnation of mining operations. In this manner, the mines of this district have passed from hand to hand during long intervals of time until, ultimately, a few Argentines possessing greater advantages and sagacity than their predecessors, reopened the copper mines and transported the mineral by means of pack mules two and a half days journey to an establishment of fundition erected at a place called Tilimuque, situated at a distance of 8 kilometres in an easterly direction from Chilecito. At this establishment, the mineral was selected, calcined and reduced in reverbatory furnaces to a poor regulus which was afterwards subjected to other calcinations and reductions until brought into a fit condition for the market.

The mine from which the principal quantity of copper ore was supplied to the reduction works, was the celebrated "*Upulungos*", which previous to the time of my examination and afterwards, was exploited with excellent results.

Some of the mines in this district have, according to the best information attainable, yielded fabulous quantities of silver, such as "*San Francisco del Espino*", in which an inmense cavern was discovered full of native silver in a finely divided,

or powdery condition. This old mine yielded silver which, at one time, was sold in the surrounding villages to the value of £ 16·000. This curious deposit of silver ore appears to have been extracted in a comparatively short space of time. Afterwards the mine was sold for the sum of £ 6000, but as the new owner did not possess any technical mining knowledge or courage to enable him to open the mine, it has remained in an abandoned condition until recently.

Other mines in this district have yielded considerable quantities of gold, which occurred in porous ferruginons quartz; but further in the deep, the nature of the mineral veins changed, introducing, with the gold, pyrites of copper and iron. Occasionally, some small veins of gold have been known to occur and run parallel with and sometimes in contact with the principal veins of copper; but these *guides*, as they are generally called, were not continuous. The larger or principal mineral veins, however, always contain a considerable quantity of gold and silver, independent of the *guide veins* noted above.

A large number of mines, containing copper, silver and gold have been conceded from time to time by the provincial government, but the majority of the persons who obtained them did not possess sufficient capital to enter upon a *bonafide* exploitation. Such operations were reserved for modern times.

As previously noted, various classes of copper ores exist in this district, such as *grey copper, pyrites, green and blue carbonates of copper, enargite, famatinite, silicate of copper*, etc., etc. A series of analyses have been given in chapter III.

The proportions of green and blue carbonate of copper diminishes in depth, occuring generally in the small cavities formed in the body of the mineral. The constituent parts of *enargite* and *famatinite* have already been given in the analysis numbers 9, 10, 11, 12, 13, 14 and 15 respectively.

The proportions of the different classes of metalliferous mi-

nerals which formed the copper veins, vary considerably, because the base elements present affect the produce of metal extracted from the mineral and, for this reason, different parts of the same vein will offer variations in richness.

The *Mine Upulungos.* Is one of the principal copper mines in this district and has been worked to a considerable depth yielding a large amount of copper ores containing gold and silver.

The veins of copper range from 0^m20 to 1^m20^c, but the average may be taken from 70 to 80 centimetres. The principal one runs in a nort east and south west direction, dipping towards the north west, at least one other vein of mineral exists in this mine.

In recent times, it would appear that the vein of mineral "*Verdiona*" existing in the mine of that name, has been found in the "*Upulungos*" and appears to have entered it in a north western direction. The "*Upulungos*" has yielded copper ore assaying from 35 to 45 °/₀, with many variations. Formerly fnferior ores were reserved at the mine.

The establisment of reduction at Tilimuque is situated 2 1/2 days journey by mule from the mine, and at this establishment the ores are mixed in such a manner that they would assay from 12 to 15 °/₀ of copper. In general such copper mineral contains on an average 70 ounces of silver and 1·28 ounces of gold per English ton, but the richness of the ore is variable.

A large sample of 937·5 tons of copper ore extracted from the "Upulungos" yielded as follows:

Copper	15·458 °/₀
Silver	66·2323 ounces per ton
Gold	1.239 " " "

Other samples of mineral yielded at the rate of 1·4 to 1·62 ounces of gold per ton.

In an ordinary way the mineral reduced to a regulus in re-

verbatory furnaces has yielded from 5·83 to 6·72 ounces of gold per English ton, i. e., that the gold in the crude mineral was concentrated in the regulus, in the proportion of about from 60 to 65 °/₀ of copper.

The mine "*Mellizas*" is a continuation of the "*Upulungos*" towards the south west and, consequently, the same vein of copper ore occurs in it, but it is divided into two branches, the thinner and poorer of which was exploited by the "*Esperanza*" Company.

The mine "*Bella Argentina*", is a continuation of the "*Mellizas*" further towards the south west, but there is no data to hand referring to its exploitation.

The mine *Compañia*, is joined to the north eastern limits of the "*Upulungos*" and is located upon the same vein of mineral.

Another copper vein crosses from the "*Verdiona*" mine. Considerable quantities of rich copper ores have been extracted from the "*Compañia*".

The mine "*Estrella*" is a continuation of the "*Compañia*", more to the north east, but the writer has no knowledge of its productive qualities.

The mine "*Alicia*", has been located further to the north east, and is separated from the "*Estrella*" by an intervening space, but it does not appear that any work has been done in it.

The mine "*Carmen del Valle*" is supposed to be situated upon the same vein of mineral as exists in the "*Alicia*" and is in the same condition.

The mine "*Verdiona*", is situated towards the base of the mountain, south of the "*Upulungos*", and is the central mine of a large group of others surrounding it. This mine has been exploited from time to time to a considerable depth, and a large quantity of copper ore containing a high percentage of gold and silver extracted. The writer possess samples of *Enargite* from this mine containing visible clusters of native gold.

It is believed that the workings from the "*Compañia*" and other mines have been continued into the "*Verdiona*".

On one occasion, a large sample or parcel of 178 tons of copper ore was extracted from this mine which yielded at the rate of 1076 ounces of silver, and 1060 ounces of gold per English ton. Undoubtedly the "*Verdiona*" has been one of the richest mines in this district.

The mine "*Andueza*" is situated to the south of the "*Verdiona*", and one of the veins of copper ore existing in the latter passes into the former. No reliable information is at hand referring to its exploitation.

The mine "*Placilla*", is situated to the west of the "*Andueza*"; but it has only been exploited to a small extent. It is, however, affirmed that this mine has yielded and is capable of yielding a large quantity of copper ores containing gold and silver. This mine is surrounded to the north west by other copper mines, and the mine "*Atacama*" joins the "*Precilla*" to the south western. The mine "*Julio Roca*" joins the south western corner of the "*Atacama*" and has been located upon veins of mineral bearing nearly due east and west.

The mine "*Panzona*" is located at some distance to the south of the "*Placilla*".

The mine "*Las Cuatro Mercedes*" is situated a little to the "*South of the Compañia*" extending for the length of two concessions southward, and part of its western limits is joined to the "*Verdiona*" and "*Andueza*".

Another group of mines called "*Maria Ester*", "*Hector*", "*Pepita*" and "*Sara*" has been located a little to the north of the "*Compañia*" extending four concessions in length northward. Various other concessions of mines were also located to the west and north west, and the workings made upon these proved that they are rich in silver and gold.

Several other groups of mines of a similar character exist

in the Mejicana mountains, some of which are located to the east of those last noticed; but considering that the economic minerals contained in them are similar to those extracted from the "*Upulungos*", no particular description of them is necessary.

The mine "*Santo Toribio*", is located in a south eastern direction from the "*Upulungos*", and when the workings in this mine had reached a depth of 15 metres, it yielded copper from 16 to 20 °/₀ with from 48 to 78 ounces of silver and 1·75 ounces of gold per ton. Various assays, however, gave different results.

The mine "*Dos Hermanas*", was conceded about 1847, and it was located upon three parallel veins of mineral containing a large quantity of gold. The mine is situated in a district at a considerable distance in a northern direction from the "*Upulungos*". In the older time this mine was worked to a depth of 22 yards and yielded from 40 to 56 ounces of gold per ton. Samples from the spoil banks have been assayed to yield from 1 to 2 ounces of gold per ton.

The mine "*Emperatriz de las Indias*", is a continuation to the south west of the "*Dos Hermanas*". The mine *Gladstone* is an extension of the "*Emperatriz* de las Indias", and located upon the same veins.

The mine "*Lord Beaconsfield*" is situated at a considerable distance in a north east direction from the "*Upulungos*". It is located upon two veins of mineral containing a considerable quantity of gold. This vein of mineral passes into the mine "*Piedras Grandes*" situated to the south east of "*Lord Beaconsfield*".

The mine "*Piedras Grandes*" has been worked to a considerable depth, and its average produce was, at the least, of from 3·6 to 4 ozs of gold per ton.

Various other concessions of mines have been located in different localities in these districts.

Not long since, a syndicate or Company was formed in London, under the name of the "Famatina Development Corporation Limited", and it has acquired an important group of mines in the Mejicana mountain district. This company commenced to develope their mines in a systematic manner and soon afterwards employed 300 men.

Mr. W. Treloar had the goodness to inform the writer that this company had in hand "at least 7 *cross cuts* going in an eastern and western direction and had discovered several new copper lodes. At that period, June 1903, there were about 50 mines under exploitation" by the various companies engaged in mining in this district. The writer has not, however, yet been able to obtain returns of the quantity of copper ores raised by the various companies. It is however reported that they "are doing well".

One of the companies referred to is that of Mr. Jaime Cibils Buxareo, possessing another large group of copper mines in this district. It is reported that a large quantity of copper ore has been extracted from these mines and reduced at an establishment of fundition which this company possesses near to Chilecito. It is also reported that this concern has been turned into a limited liability company in London.

It may, therefore, be inferred that this new company will initiate mining and smelting operations upon a large scale.

Mr. Victor Koch, a noted and exceedingly active mining Engineer, formerly possessed important copper mines in this district as also a reduction Establishment, and it is understood that he is one of the representatives of a company for the exploitation of the mines in question. Mr. Koch has exerted himself to a large extent in directing the attention of foreign capitalists to the advantages to be derived from mining in this region.

There are no particular reports to hand referring to the

mining operations of the other companies: however, a map in the possession of the writer, represents no less than 11 companies, or representatives of companies, possessing mines in this district.

From what has previously been said in this chapter, it may be inferred that the older mines which have been under exploitation for a considerable time in this district, would always retain the same names and relative position one to another; but such concessions of mines as have not been worked have been subject to a change in name and, in some cases, limits, depending upon necessity and caprice of the persons who obtained the same mines in concession at different times as, also, under different names. For these reasons, a plan of all the mines in the Mejicana district taken at one period, would be likely to differ to a considerable extent from what it would be after one of the changes noted.

The writer has examined several maps of this mining district upon which the mines are shown; but there did not exist any agreement between them. This circumstance shows that they had been constructed at various epochs and probably for particular purposes. For the reasons assigned, some of the undeveloped mines referred to in this chapter have recently changed names and owners. However, for the purpose of this work, the writer has preferred to retain the names of the mines as they existed when he inspected the district.

The Ophir Mining District.

This district is situated to the north west from the mine "*Upulungos*", and at no very great distance from it. The title given to this locality indicates that the mineral veins

existing in the mines contain gold, and although the writer visited this locality some years since, he could not obtain samples of mineral and, consequently, from personal knowledge, he is unable to state what percentage of gold and other metal could be obtained from the mineral.

However, the Engineer who came from London on behalf of, or for the formation of the "Famatina Development Corporation" would, one would suppose, have been satisfied that the presence of gold in the mines in question was sufficient to induce the company to acquire the mines in this district. Recent reports indicate that the company has placed some workings in these mines, but with what results is not known.

The extension over which economic mineral lodes may exist is not known, as far as the writer is aware, but it would appear that this district is not a large one.

The following table represents some parcels of mineral extracted from one of the mines in this district, with corresponding assay produce.

N.º 51

Weight in kilos	Gold — Grammes per ton	Silver — Grammes per ton	Copper — Per Cent
2,580	209	518	7·00
445	207	440	7·50
872	214	608	7·90
1,647	112	604	7·50
933	144	589	7·10
1,045	112	494	6·50
434	226	608	5·85
605	270	732	6·45
1,588	188	570	6·80
1,725	194	637	8·40

N.º 52

Weight in kilos	Gold — Grammes per ton	Silver — Grammes per ton	Copper — Per Cent
2,060	232	513	6·85
1,150	209	409	7·40
406	248	352	7·80
568	176	551	8·00
942	316	741	7·80
692	194	770	8·20
1,714	228	836	7·00
480	407	980	6·80

The succeeding table exhibits similar elements as those given above.

N.º 53

Weight in kilos	Gold — Grammes per ton	Silver — Grammes per ton	Copper — Per Cent
780	103	320	5·40
560	85	300	4·00
1,050	78	400	4·40
302	186	600	5·80
260	80	350	4·00
825	125	400	4·10
414	132	418	4·65
1,587	77	280	3·80
1,310	69	314	4·50
1,083	96	366	4·00
1,562	112	319	5·10
836	48	385	3·80
733	112	304	5·30
470	105	428	4·20
680	123	409	4·00
1,394	131	395	4·80

The weight of mineral shown in the last preceding tables were extracted from one of the mines in 8 months.

The Mining District of Ampallao.

This district is situated to the north east of the Mejicana, and has been explored to a small extent only, consequently its limits have not been determined. In it exist various mineral lodes running in various directions, and the composition of the mineral consists generally of quartz mixed with blende, iron, silver and gold. Some of these mines have been examined in a superficial manner, and although some of them contain galena, but little attention has been devoted to a formal exploitation of the mines. This has partly resulted from the fact that the mines in other districts were more accessible and better known and, also, that up to the present time the transport of poor minerals from distant regions by means of pack mules could not be undertaken on account of its slowness and high cost of this mode of conveyance.

In a certain sense the Ampallao mining district may be considered to be a continuation of the Mejicana mountains and, consequently, it is possible that other and more important mineral lodes may be discovered there.

At one time, there existed in this district, 11 concessions for mines of silver and other metals; 7 for silver and iron; 8 for galena; 1 for gold and 2 for auriferous oxide of iron, and 1 for silver and carbonate of iron.

Considering that the price of silver has been reduced to a large extent, it is hardly likely that anyone would undertake silver mining in this district. This is no reason, however, why the district may not receive attention, for the reason that new descoveries of other mines of commercial value may be discovered.

The Bayos Mining District.

This exceedingly important mining district is situated between those of the Cerro Negro, Calderas, Tigre and Mejicana districts. There existed 11 mines of copper, silver and gold in it, some of which have been exploited and have yielded an abundance of rich ores. In former times, the whole of these mines could not be exploited for the want of sufficient capital, and cheap and rapid transport; but this state of things has passed away and the present owner of these mines, Mr. W. Treloar, has exploited one of them fo ra considerable time. The principal lode is that of "*San Pedro*", and is reported to be 3 $^1/_2$ metres in thickness. The class of ore extracted from it is *Enargite* mixed with sulphate and pyrites of copper, carrying a large per centage of silver.

It would appear that the "Famatina Development Corporation Limited", has acquired some of the mines in this district from Mr. Treloar, so that we have evidence from authorized persons that these mines are exceedingly important and valuable.

About 20 distinct and well defined lodes or veins of copper ore are known in this district, having a thickness of from 50 centimetres to 6 metres. Two of the mines conceded, i. e., "*San Pedro*" and "*Catalina*", with the adits *Victoria* and *Albert* are being exploited by Mr. W. A. Treloar. The following table exhibits some of the quantities of mineral extracted with the corresponding assays.

N.º 54

Weight in kilos	Per centage of Copper	Silver, kilos
20,000	21·55	4·310
10,147	23·90	2·425
9,853	23·90	2·354
4,301	10·40	·447
15,699	10·40	1·632
20,000	15·75	5·480
20,000	13·48	3·880
3,038	18·02	3·600
16,000	9·76	2·480
4,000	8·19	1·680
16,441	10·90	2·080
5,603	11·02	1·880
15,931	11·09	1·200
18,993	11·65	1·180
9,037	9·70	0·680
7,602	14·07	1·060
5,569	14·05	0·980
16,931	15·56	1·080
10,652	16·50	1·490
2,294	11·02	0·800
9,634	18·08	2·900
8,662	16·06	1·040
3,843	25·01	1·680
2,852	17·32	2·000

The following Table contains elements similar to the preceding.

N.º 55

Weight in kilos	Per centage of Copper	Silver, kilos
21·664	10·50	0·900
5·198	16·25	1·180
16·699	16·30	0·970
2·551	8·70	0·760
5·692	17·50	1·160
2·313	17·80	1·020
5·014	17·10	1·070
4·986	14·20	0·870
42·640	15·60	1·080
7·870	12·80	0·920
17·105	15·20	1·000
2·806	18·70	1·220
5·473	18·70	1·666
2·479	16·30	2·230
21·237	16·40	2·100
5·527	16·70	4·070
8·037	16·50	1·600
2·156	18·10	3·020
6·994	15·60	1·640
2·873	12·00	2·360
2·664	7·800	1·280
1·869	8·900	1·600
·378	8·300	2·110
3·501	9·20	1·780

The figures in the preceding tables speak for themselves proving that these mines possess great comercial value.

The Santa Rosa Mining District.

This district is situated at no very great distance from those of the *Calderas,* and in it mines of copper exist; but the workings placed in those mines do not appear to have been very extensive. The writer does not possess any details referring to the number of mines existing in this district or of their capacity of yield.

Gold Washing Districts.

The first of these is situated near to a place called *La Escalera,* at a distance of about 4 leagues from the town of Famatina, and 9 leagues from that of Chilecito. Between the *playa de los Ramblones* and the *river Achavil,* about 25 concessions of gold washing mines have been granted.

Generally they run in a north westerly direction from the *playa,* but three of them have been colocated upon the bend of the river *Achavil,* and these run in a north easterly direction. These are called "*Mariposa*" numbers 1, 2 and 3. The river *Achavil,* and another small stream or Acequia pass through the mines "*Mariposa*" numbers 2 and 3, and it would appear that these have been proved to a great extent, and the others, which are situated at a longer distance from the river. It is reported that the auriferous sand is very thick and that the bed rock has not been reached; but there is no informatian to hand referring to the yield obtained from these gold washings.

The Rio Blanco and Angulos Mining Districts.

Concessions of mines for gold washings and copper mines have been obtained in the first named district and it is believed that some work has been done in order to prove the quality and yield of the mines. Of the last mentioned, no information is possessed referring to the number of mines, quality or capacity of yield.

The Mazan Mining District.

This district is situated to the north east of Chilecito and, at a distance of about 2 leagues from the frontier line of Catamarca. In a small stream at that place, tin ore has been found and is apparently a new discovery; but there is no information to hand referring to the quantity of ore extracted or to be obtained.

The writer is aware that a deposit of tin ore in the form of *Cassiterite* was discovered some years since in one of the mountains not far from Tinogasta, in the province of Catamarca, but after a few tons had been extracted the deposit is reported to have cut out, and could not be traced in the adjoining rocks. The late brothers Tejerina resided at Copacabana, and when the writer visited the family referred to, some years since, he obtained the information cited above, as also some beautiful samples of *Cassiterite* in crystals which had been obtained from the deposit referred to.

Considering that the surface portion of mineral veins have been much denuded, and the detached portins carried to lower levels, it is not so surprising that tin ore has been found in the small stream at Mazan.

There are various other places in the vast mountain regions in the province of La Rioja, not thoroughly explored such, for example, as Los Llanos, Cerro Nevado and its ramifications in Famatina and other places. If, however, this were to be done in a systematic manner it is highly probable that other important mining districts would be discovered.

Information referring to the modes of transport will be found in another portion of this work.

Recapitulation of the Best Known Mineral Districts.

Mejican and Ophir	Copper, gold and silver mines.
Los Bayos and Jagüel . . .	» » » » »
Cerro Negro, Calderas, Tigre and Humango	Silver mines.
Santa Rosa	Copper mines.
El Oro and Rincon del Cobre	Gold mines.
Mariposa, Rio Blanco and Angulos	Gold washing mines.
Mazan (newly discovered) .	Stream tin deposits.
Valley Hermoso	Cobalt and nickel mines.

CHAPTER VI

Mines and Mining in The Province of Catamarca.

This province has an irregular form extending northwards from that of Rioja and is situated between the latter, those of Cordoba, Santiago del Estero, Tucuman and the national territory of the Andes. It is limited to the west by part of the frontier line of Chile, and has an area of 123,138 square kilometres being 1·43 times larger than the province of the Rioja.

Its known mining districts are situated at long distances one from another, and a proper development of the mines and metallurgical industries of the larger portion of these districts have suffered and been retarded to a considerable extent consequent upon inadequate transport. However, this state of things is rapidly disappearing in some parts of this province, but a considerable amount of time must elapse before an adequate railway service is provided in all parts of the low levels and to the mining districts which are situated in elevated mountains regions.

Some years since, the writer made an expedition into this province starting from the town of Chilecito, in the province of La Rioja, passing through the village of Famatina, Angulos,

Campana, Copacabana, Tinogasta, El Puerto, Anillaco and Medianito, arriving at the mines in the Hoyada district after eight days journey on mule-back.

Between Campana and Copacabana, there exists an open arid and fearfully hot camp during the summer season, the effects of which was keenly felt by some of the companions of the expedition and in one case caused an insolation.

Further towards the north, a second camp occurs, through which it was necessary to pass and was found to be in a most intolerably hot condition. The sub-soil consisted of a fine dust of pumice many metres in depth, in which the heat of a tropical climate had accumulated to an enormous extent; the heat ascending from the sub-soil and descending from the almost perpendicular rays of the sun, rendered travelling exceedingly wearysome, difficult and dangerous. At each step of the mules, their hoofs sank into the pumice dust, thus retarding the usual progress: in fact the heat was so grea that the water carried in protected barreles on the pack mules became so heated that it could not be employed for drinking purposes. Fortunatey, after a constant ride of fourteen hourst a beautiful mountain stream of water was found at the extreme northern end of this terrible camp which is much fitter for a picture in Dante than to occupy a place upon this beautiful and fertile earth.

The writer has purposly dwelt upon the difficulties encountered in this expedition for the object of guiding those who may follow the same route, and to exhibit to them the necessity of making a proper equipment before undertaking such an expedition.

From the beautiful mountain stream noted above, the journey lay through narrow defiles, mountain roads and deep gorges. The heat experienced all along this route was almost insupportable. The last days journey brought to view a series of

large and elevated *porphyritic* ridges with various intrusive dykes. In point of fact, the Hoyada district seems to be the centre of extensive ancient volcanic action. In the elevated part of one of these mountains, the writer observed a thin joint in the *porphry* rocks in which metalliferous mineral had been deposited. At a lower level, a small tunnel had been formed, and at some 4 metres within the mass of rock, a vein of metalliferous mineral was found of considerable thickness and richness. Some parts of it had a thickness of from 2 to 3 metres, with variations, and the workings carried on appear to have yielded a considerable amount of gold, silver and copper. Some of the workmen had incautiously extracted the pillars, which had been left at a depth of 60 metres to support the roof, so that the mine was in a ruined condition when the writer visited it.

The average yield of some samples, which he obtained from some accessible portions of the mine assayed, from 1·8 °/₀ to 14·6 °/₀ of copper and as high as 800 ounces of silver per ton.

The most celebrated mines in this district are those known by the name of "*Panchita*", "*Rosario*", "*Descubridora*", etc.

The following brief description of a few of the mines of this district is based upon notes taken during the visit of the writer to this remote region.

At the mine "*Andacollo*", the barometer read 17·55 inches and the thermometer 38° centigrade. The miners' *ranchos* were placed against a porphiry wall, the face of which bore south 25° west. The entrance to the mine "*Andacollo*" was situated at about 200 metres to the nort east of the *ranchos* and at the surface the vein of mineral showed no more than 2 inches in thickness, consisting of green and blue carbonate of copper.

The works in the mine were carried to a depth of 40 metres, but the thickness of the vein of mineral at this point could

not be ascertained. A sample of 13 tons extracted from this mine assayed at the rate of 10 °/₀ of copper, with 218 ounces of silver per ton, with some gold.

The mine "*San Pedro*". This mine was discovered in 1862 but the workings in it did not pass 20 metres in depth. The vein of mineral, green carbonate of copper, did not exceed 9 inches in thickness, and one ton of mineral extracted from it yielded 12 °/₀ of copper and 143 ounces of silver per ton.

The mine "*Panchita*", is situated at no great distance from "*San Pedro*". It could not be examined at a greater depth than 100 feet, the passage downwards from this point having been stopped by the fall of the roof. The vein of mineral ran in the direction of north 35° east, with a dip of 48° towards the south east. At the depth named the thickness of the payable part of the vein had no more than 12 inches, but, at the deepest point, it is said to have had a thickness of 0·75 centimetres. It has yielded a considerable quantity of copper ore containing a high percentage of silver. Samples obtained by the writer yielded from 20 to 30 °/₀ of copper with over 2000 ounces of silver per ton. Doubtless this mine will prove very productive in the depth.

The mine "*Sacramento*". This concession of a mine has not been proved in depth, and the vein showed very poor at the surface, consisting of patches of green carbonate of copper mixed in a decomposed *porphyritic* rock. The mines "*San Roman*", "*San Blas*", "*Espino*" and "*Candelaria*" were found in a similar condition.

The mine "*Rosario*". This mine has already been referred to. The works were commenced upon a vein of *grey tufa* between walls of porphry running in the direction of uorth 60° east. This mine was examined to a depth of 60 metres, but the passage downwards was impeded. Considerable quantities of metalliferous mineral had been extracted from this mine. The

contents of the vein consisted of various classes including *polibacite;* and when it was present with the other classes of ores, the mass had a rate of yield of from 20 to 25 °/₀ of silver. Other classes of ore yielded at the rate of 10 °/₀ of silver. The owner of the mine stated that *Eukairite* occurred at a depth of 30 metres, where a general change occurred in the nature of the vein and introduced a blackish mineral which, when exposed to considerable heat, was converted into silver. Assays of mineral obtained from this district have been given in the II chapter.

The mine "*Descubridora*". The vein of mineral occurring in this mine bears south 85° west with a dip of 70° northwards. At the surface the mineral vein is very thick consisting of white tufa in which the copper ore is distributed. At the depth of from 3 to 4 metres, green and blue carbonates were encountered, and at a depth of 5 metres the vein of copper had a thickness of 1 metres. The other parts of the vein consisted of *quartzite tufa* and other elements. The vein extended to a total thickness of from 4 to 5 metres, but it did not exist in a very compact condition.

A considerable quantity of copper ores had been extracted from the superficial part of this mine, but as the vein did not yield more than 10 to 13 °/₀ of copper and being poor in silver, it was found that the cost of transport was too high to permit of the exploitation of the mine. However, the mineral is in a good condition for smelting and the writer believes that the copper ore will prove richer and be found in great abundance in the deep.

The mine "*Concepcion*", is situated in the mountain of the *Volcano,* and the vein of mineral in it is very similar to that in the "*Descubridora*", but less in thickness.

Up to the present, the works placed in these mines have been upon a small scale, with limited capital, and cannot be taken

to represent the produce of this district when it is thoroughly explored, other mines discovered and a proper and economic system of mining and transport have been introduced. The writer believes that this mining district will prove of great importance in the future.

The mountains of Famatina run into and through this province, but are known under different names, and are divided into various chains of great elevation, joined together by parallel and lateral ridges, and extend over a considerable area. These mountain regions are intersected at various places by fertile valleys and passes.

In the whole of this distance, i. e., from the northern frontier to the southern limits of the National Territory of the Andes, veins of copper ore have been discovered in the different districts, and the writer has examined samples of excellent quality.

In the neighbourhood of San Francisco, a district situated to the south east of the Hoyada, and near to the pass of that name leading to Chile, exist various mines of copper.

From this pass, southward, there are other mountains to the west of Fiambala, and in front of Retamos, they are known to contain veins of copper ore, in fact not long since an old Indian mine was discovered there containing a vein of carbonate of copper, samples of which yielded gold and silver.

These mountains also yield native copper, samples of which were assayed and yielded also gold.

In the *Cerro Negro*, which is a continuation of the Famatina mountains, and situated at about 38 kilometres in a north west direction from Tinogasta various copper veins have been discovered, samples of which have yielded gold and silver, but the mineral is ferruginous. Samples from these veins yielded at the rate of from 10 to 18 °/₀ of copper, with silver from 170 to 300 ounces per ton. They have a thickness varying from 25

to 75 centimetres. It has been reported to the writer, on good authority, that various veins of mineral rich in silver exist in this mountain, but he has not examined any samples obtained from such veins.

In a place called *Portezuela de las Minas*, situated near to the northern frontier of La Rioja, and at about 1 $^1/_2$ days journey from Tinogasta, various copper veins exist high in percentage. In the same locality, a vein of argentiferous lead occurs running parallel to those previously noted in a northern and southern direction. The spoil banks in this locality lead to the inference that the mines in question were exploited at a period now out of memory; however, as recent as 1864, some of them were again opened, but were soon abandoned because the miners did not possess any practical mode for the support of the walls of the mine which, apparently, were fragile, consisting of decomposed slate and consequently fell in. These mines were reported to be exceedingly rich in silver.

The farm of *San Francisco* is situated in the same mountain region as the Cerro *Portezuela de las Minas*, previously noted, and in that locality various thin veins of copper ore were discovered. One of these was proved to a depth of 8 metres, but the thinness of the vein was such as to prevent the continuance of the working.

At a place called *Potrero Grande*, two days journey to the west of Tinogasta, also exist various copper ore veins, but there is no notice as to the quality.

Between *Potrero Grande* and *San Francisco*, the vein of argentiferous lead existing there is 1 metre in thickness, and yielded 70 °/₀ of lead, and 36 ounces of silver per ton. The writer procured samples from the mines in the neighbourhood of *Potrero Grande* and the farm of San Francisco, which yielded 15 °/₀ of copper and 400 ounces of silver per ton.

There are, also, various other districts in the western region

of this province, where copper ores have been discovered, but the whole of this territory has never been subjected to a scientific and practical exploration by competent persons. If this were to be done, no doubt many other important mines would be discovered which, taken together with the existing veins of copper ores and the known mines would, undoubtedly, yield sufficient mineral to supply various small establishments of fundition; but to render the mining and reduction establishments, which may hereafter be introduced, profitable undertakings more extended and cheaper modes of transport must be provided for this section of the province.

The general inspection of the accessible mines in the districts referred to having been finished, it was resolved to continue the expedition to the north east of the province where the important mines in the Cerro de Capillitas exist.

From Tinogasta the route lay through the old historical town of Londres, now consisting of but a few scattered houses, and the first days journey ended at that little paradise upon earth, the town of Belen. The next day the journey was continued through a long and deep gorge down which rushed a river at great velocity, emerging from this the route ran over a long hot arid camp. The expedition had been accompanied from Tinogasta by Doctor Guillermo Leguizamon, and at the end of the second days journey we reached the estate of this gentleman, whose family received us with every hospitality, in Hualfin.

In the mountains surrounding this estate, exist a number of mineral veins consisting of iron mixed with quartz, poor carbonate of copper with silver and gold. Small works have been conducted upon some of these veins to a depth of 15 metres. It would appear that the principle object was the extraction of a small quantity of gold contained in the mineral. When the writer visited these mines, if they deserved the

name, the works had been abandoned and the miners *ranchos* were in ruins. In the same Cerro, and at a place called *Agua de Onis*, shallow pits had been formed upon some veins of mineral honoured by the name of "*Descubridora*". The principal vein consisted of ferruginous matter, decomposed quartz containing a small quantity of gold. This vein had a thickness of 33 inches. Another mine was also opened, the mineral extracted yielding about 90 ounces of silver per ton, with a little gold. A third mine had been opened to 36 metres in depth and, according to information received, the mineral yielded 11 °/₀ of copper, 6½ ounces of gold and 94 ounces of silver per ton.

Other mines had been located in the same neighbourhood which yielded pyrites of copper and chloride of silver.

At the estate of Don Abel Rios, at *Papa Chacra*, about 6 leagues to the north of Hualfin, various veins of copper ore exist, samples from which have yielded from 10 to 20 °/₀ of copper with some gold and silver.

At a distance of about 2 leagues west of *Papa Chacra*, and upon the estate of Don Vicente Abarza, and in a place called Minas, various veins of copper, lead and silver exist.

The Cerro of Culumpajal is situated at a distance of abou 10 leagues to the north west from Hualfin, and, there, exist various veins of quartz containing gold and it has been stated that a large yield was obtained.

At another place called *Corral Quemado*, situated at a distance of 5 leagues from Hualfin, mines exist which were worked for silver and gold; also, at a distance of 8 leagues north of Hualfin, various other mines have been worked for silver and gold.

The districts referred to, surrounding Hualfin, and others in this section of the province, have never been explored in a proper manner, and the writer is aware that there exists a large

number of mines of which no particular account could be obtained.

However, samples of mineral from one of these, was in the possession of doctor Leguizamon, and an examination of it proved to the writer that it was exceedingly rich in silver.

The journey was again resumed by the expedition referred to from Hnalfin, passing over hills, through deep valleys, hot narrow gorges between the mountains, almost abandoned by man and beast, arriving drenched from the effects of a tempest, in the evening, at a poor isolated ranch, situated in the narrow gorge of *Vis-Vis*. The accomodation offered within this ranch was impossible owing to the vast number of voracious insects of various kinds which infested its precints. We were, therefore, obliged to, sleep in the open, under a leaning roof. The tempest referred to continued during the whole of the night, and as the outshed under which we attempted to sleep had the water proof qualities of a riddle, we found ourselves in a miserable condition in this dreadful refuge, so that we were glad the next morning when the sun illuminated this piece of desolation.

From this region, the journey to Andalgala lay in a north eastern direction, but the mule track which we had to follow had all the directions which could be found in the mariners compass. After 2 or 3 hours ride from Vis-Vis, at a place called *Ampuyaco*, and in a shaltered place in the valley, we were surprised by shouts in English from a man wearing a red shirt "Are you English?", and as two of our party belonged to that nation, we were welcomed to the encampment, where we had the pleasure of meeting Lord Dormer, his secretary and party. After a brief conversation, during which we discovered that his Lordship was a celebrated Indian sportsman and had made an expedition into this Republic for scientific and sporting purposes, chocolate and biscuits were supplied,

and in this way we spent a very agreeable half hour. His Lordship regretted that he could not break camp and pack his extensive equipage in sufficient time to accompany us, but promised to join us again at Andalgala. From this place the mule track lead through difficult narrow passes and a succession of other hot valleys until we merged from the mountain region into the great and unprotected camp which extends for a long distance to Andalgala.

Lord Dormer soon arrived and we again had a very agreeable conversation

We afterwards made an examination of the large establishment of fundition situated at Pilciau, belonging to Mr. Samuel Lafone Quevedo, and we organized a journey to the mountains of Capillitas, where some of the most important copper mines in this province exist. We found the mule track to be similar to those in other mountains regions with some agreeable exceptions.

The distance from *El Fuerte de Andalgala* is about 3 ½ leagues running in a northern direction, and, under ordinary circumstances occupies 1½ days in traversing it. After passing the slightly inclined northern portion of the great camp of Andalgala, the first branches of the cerros were encountered and the entrance to the mountain gorge appeared. At some distance from the entrance, here and there, were found large groves of shady trees and flowering aromatic plants. The trees consisted of algarrobos, talas and others with many climbing plants forming innumerable festoons in various fantastic and graceful forms. In one of these delicious shady places, groves of *verbena* plants were growing to a height of 8 feet. The higher regions were soon reached and after various ascensions and descensions we passed over some of the ramifications which form part of the great elevated and snow capped cerro of Aconquija, and from this height we obtained a delightful

view of the green trees extending in the valley below through which we had passed. As the journey continued, other gorges and low mountain ranges were traversed until the Cerro of Capillitas came in view.

The Cerro of Capillitas runs in a north eastern direction, but it is separated to the north from the *Cerro del Cajon* by the low level extensive camp of *Santa Maria.*

Like all other mountains in this part of the Republic, the Cerro de Capillitas is divided into various ramifications, and connecting gorges difficult of access.

The formation of this Cerro consists generally of *gneiss, granite, porphiry, trachyte* and *irachytic porphry.*

Some of these intrusive deposits are in contact with the gneiss and others with the granite.

In one of the elevated branches of this mountain, quartz veins exist in various states of decomposition, and in some of the detached masses, beautiful crystals of black *turmaline were* found.

The Cerro of Capillitas extends over a very large area, and in part of it a large number of copper mines exist, the ore from which contains a large percentage of gold and silver.

The mine "*Restauradora*". This is one of the most important mines in the district, and has been exploited for many years by Mr. Samuel Lafone Quevedo & Company.

In the first chapter upon ancient mining, all that is known about the old workers in this and other mines has been given.

On one occasion the writer examined the whole of the accessible parts of this mine, and from various measurements taken of the thickness of the principal vein then in view, it was proved to be very irregular, and some parts of it measured from 2·5 to 4 feet in thickness. Considering, however, that various parts of the mine was in a dangerous condition, it could not be examined, consequently, the average thickness of the vein of copper ore was not determined.

A very long gallery has been driven from the side of the mountain to interest the vein of mineral exploited at higher levels and, also, such others as may exist in the mine, and the writer understands that at the time when Mr. Samuel Lafone Quevedo directed the works, the gallery referred to cut a very important and rich vein of mineral at its termination.

Samples of copper ore obtained from this vein, were presented to the writer, and it assayed as much as 40 °/₀ of copper, with a large percentage of silver and gold. In fact, one of the samples carried native gold which was clearly discernible without a microscope.

Plans and sections of this mine were published by the writer in his large official work in 1888, to which reference can be made for particulars as to the number of galleries which had been driven in succession at different levels. This mine was worked upon the best system of any in the Republic.

Mr. Samuel Lafone Quevedo commenced exploiting it in 1860, and the works have been continued for a series of years by him, or, in point of fact, up to the time when it was recently transferred to a London Company.

The writer was favoured by an inspection of the account books kept at the mine, and from them he determined that from 1860 to 1888, the total amount of copper ore extracted from the mine had been large.

The mineral extracted from this mine consisted of pyrites of copper, grey copper, other classes mixed with pyrites of iron, etc., in variable proportions. Sometimes, small quantities of galena, blende and antimony were mixed with the copper ores, but these elements did not occur frequently nor in large quantities.

The following assays may be taken to represent the general yield of the vein of mineral at the periods indicated:

TABLE N.º 1

YEAR	Percentage	Weight of mineral in quintals
1. 1867	19·3 to 33·0	upon the quantity of 4686
2. 1869	16·0 " 28·0	" " " " 4040
3. 1870	16·0 " 31·0	" " " " 3070
4. 1873	13·0 " 29·0	" " " " 6904
5. 1886	13·4 " 29·2	" " " " 3598

There were, however, variations, the ores assaying on some occasions from 21·9 °/₀ to 25·6 °/₀ of copper, consequently it is not to be expected that the mine would have yielded a less percentage of metal after 1886. On the contrary, it is fair to infer that some of the veins of mineral existing in this mine would yield a higher percentage.

The copper mineral which has been founded at Pilciau, contained pyrites of copper, pyrites of iron, grey copper, etc., etc.; and was prepared in such a manner that the bulk would yield from 11 to 15 °/₀ of copper. The pyrites of copper, however, in some cases, assayed from 13 to 18 °/₀ of metal.

Those portions of the mineral vein which yielded galena, pyrites and blende have assayed 9 °/₀ of copper, 60 °/₀ of lead, and from 0·071 to 0·103 °/₀ of silver. Other samples yielded 7·9 °/₀ of copper, 0·106 °/₀ of silver and 27 °/₀ of lead; but this class of mineral was not found in large quantities.

The assays of the ores have varied according to the conditions of the mineral vein, and, for this reason, the average percentage of copper, silver and gold realised from a reduction would naturally depend upon the proportional weight of each class of crude ore, and the amount of brute elements present in them. It is, therefore, necessary, and is, in fact, the custom to select and mix the ores in such a manner as would give the

best results, and such ores as contain a large percentage of lead, some blend and but little silver ore, are as far as is possible, rejected.

A large sample of copper ores extracted from this mine yielded the following elements:

TABLE N.º 2

CLASS OF MINERAL	Per cent of copper	Per cent of silver	Per cent of gold
N.º 1	27·7	0·1050	0·0015
" 2	17·7	0·0810	0·0015
" 3	18·4	0·0885	0·0020
" 4	17·5	0·1055	0·0025
Totals.	81·3	0·3800	0·0075
Average	20·325	0·0950	0·001875

The exact average, as before noted, depends upon circumstances.

A general analysis of all the elements contained in some of the samples of ores obtained from the mine "*Restauradora*", made in the laboratory at the establishment of Pilciau is as follows:

TABLE N.º 3

N.º 1		N.º 2	
Copper	34·170	Copper	26·380
Carbonate of copper. Malachite	10·169	Carbonate of copper. Malachite.	1·015
Oxide of copper . Sulphate of	2·180	Iron	19·025
Sulphuric acid. . . copper .	2·145	Hidrated oxide of iron.	0·373
Water.	0·482	Zinc	2·824
Iron	5·598	Bismuth.	0·420
Zinc	1·692	Lead	0·273
Lead	3·180	Silver.	0·115
Silver	0·149	Gold	0·001
Gold	0·006	Sulphur	33·438
Sulphur	23·604	Arsenic	7·334
Arsenic	11·378	Antimony	0·665
Antimony.	1·415	Sulphuric acid.	0·233
Carbonate of lime.	0·565	Carbonate of lime	1·036
Carbonate of magnesia	0·319	Carbonate of magnesia.	0·401
Potash.	1·186	Potash	0·337
Soda	0·237	Soda	0·249
Quartz.	2·106	Quartz	5·752
Bismuth in small quantity	0·419		99·871
	100·000		

Reference has already been made to a rich vein of mineral which was found at the termination of the drainage gallery, which had been driven from a low level point into the mine; and Mr. S. Lafone Quevedo has been good enough to supply the following data. The vein of mineral alluded to above, was found at a point 2159 yards distance from the entrance of the drainage galliery or adit, and it had a bearing north 70° west and south 70° east from the junction of the galliery. At this point the copper vein had a thickness of 3 yards of solid ore which continued for a horizontal distance of 40 yards towards the west; but, at that point, the thickness of the vein decreased to 6 feet, still, further to the west, the vein had a thickness of 27 inches, and continued so for 10 yards. The ore consisted of grey copper, black oxide and pyrites of copper, containing a large quantity of silver and gold: in fact, the native gold could be seen in the ore without the aid of a microscope.

The rocks crossed by the vein of mineral were trachytes and granites to the west.

It would appear that similar conditions existed in the superior levels of the mine. The two walls of the copper ore veins, towards the north, consisted of granite, but towards the south they were trachyte.

In the higher parts of this mine, a proportion of *enargite*, and another class which the miners call *steely metal*, or *Kupherglance*, copper sulphides, and carbonates existed; but at lower depths these classes, especially the carbonates, diminish in quantity.

It is very important to note that at the depth of 300 yards, copper ores of a richer quality ocurred than at higher levels. The ores contained in the vein which we have described assayed from 30 to 50 % of copper, 2 ounces of silver per ton, with much native gold.

Mr. Samuel Lafone Quevedo, informed the writer, recently that other and later assays have given from 15 °/₀ to 18 °/₀ of copper, and 30 grammes of gold per ton. Also, that the pits made from the level of the adit, to intersect the lode, were suspended on account of the water which infiltrated, and which he had no means to keep out. The copper ore in the floor of the tunnel remained untouched.

It would be exceedingly interesting, as also important, to discover how this vein of copper ore would present itself in the deep. If the ore should be found to be abundant, as most likely it will, it would form an excellent case of precedence by which to judge of the probable depth, at which it would be likely to find new veins of copper ore in other neighbouring mines.

The long drainage level, or gallery, which has been driven into this mine is the best which exists in this Republic, and is a very important work for the reason that if it were to be prolonged, the veins of mineral in other mines would he intersected, and greater facilites offered for their cheaper exploitation. It ts, also, highly probable that various new veins of copper ore would be discovered.

The mine "*Santa Clara*". This mine is situated at the side of the "*Restauradora*", already described, and a gallery has been opened upon the vein of copper in it, by means of which a perpendicular depth of 73 yards is gained below the entrance gallery in the mine "*Grande*", which is a continuation of the "*Santa Clara*". Both these mines are, therefore, in a good condition to be exploited; but, as previously suggested when referring to the gallery in the "*Restauradora*" mine, the vein *Santa Clara* could be commanded by it. At the surface, the writer examined a small portion of the *Restauradora* vein which crossed that of the *Santa Clara* near to the entrance of an old adit, but it was very thin and consisted for the most

part of green and blue carbonates. It is possible that this thin vein of mineral, or a branch of it, would, probably, form a single vein in the deep. This circumstance is sufficiently interesting to form the basis of a prolonged study which would aid in the solution of various other important problems referring to the mines existing in this district.

The vein of copper ore in the mine "*Santa Clara*", and in the "*Grande*", seem to run almost due east and west, but from the adit in the gallery the vein would appear to change in direction and dip.

It is the general belief that the vein of mineral in the mine "25 de Mayo" crosses to the vein of mineral in the "*Grande*", and then runs parallel with it. It can, therefore, safely be assumed that this is the reason why the vein of mineral in the "*Grande*" has such an immense thickness.

At the depth of 24 yards below the old adit, the mineral zone contains sulphides. Both in the "*Grande*" and "*Santa Clara*"; the vein of mineral is very constant, and, without doubt, would prove as important in the depth as that in the "*Restauradora*".

In the "*Santa Clara*", the mineral generally consists of grey copper mixed with pyrites and carbonates of copper. When the mineral is poor in copper, there is a mixture of galena and blende, but this is not a frequent occurrence, neither has it any great extension. It must, however, be observed that the richest deposit of ore is found more towards the west, at a distance of 133 yards from the entrance of the adit, where, for a distance of 28 yards, the vein showed a thickness of 49 $^1/_2$ inches of nearly pure grey copper, but mixed in some places with a small quantity of pyrites of copper, containing a large percentage of silver and some gold.

The southern wall of the vein consists of decomposed granite but the northern wall is more compact. The workings

in "*Santa Clara*", have been carried to a depth of 20 yards below the adit.

The greater part of the mineral extracted from the "*Grande*", or that part called by the miners the *cold zone*, consisted of red and black oxides of copper, mixed with green and blue carbonates carrying silver. Nevertheless, grey and pyrites of copper were found in the central part of the vein. In this form, the copper ores generally occurred in the mine "*Grande*", in smaller or larger quantities, from the surface to a depth of 46 yards, from which point commenced a new zone of mineral in which the carbonates gave place to a larger proportion of grey copper, black oxides and pyrites of copper.

The vein of mineral at this depth contained some quartz, magnesia and iron pyrites, and had a thickness of 2ft. 7 inches.

However, that part of the vein containing the richest copper ore, had a thickness of 22 inches. Considering, however, the nature and particular occurrence of these veins of copper ores, it is highly probable that at a greater depth the rich mineral would fill the whole space between the walls. This seems to be proved from the variable nature of metalliferous veins in general, and from the fact that, on one occasion, in one of the superior or upper parts of the vein of mineral, the richest part had a thickness of 49 inches for a horizontal distance of 40 yards. There also exists in different parts of the principal vein branches of copper pyrites with others of quartz, which together form a vein with a total thickness of more than 6 yards; but these conditions occur more to the west where the vein presents itself in a more regular form.

Some of the copper ores extracted from this mine have been assayed and the elements determined as follows.

TABLE N.° 4

CLASS OF MINERAL	Weight of mineral	% of copper in brute mineral	% of silver in brute mineral
1.	132	44·9	0·058
2.	170	27·3	0·053
3.	138	29·1	0·074
4.	18	23·3	0·560
5.	80	21·8	0·340

The five samples of mineral in table 4 amounted to a total weight of 538 spanish quintals of 100 pounds each, and from this crude mineral 167·46 quintals of fine copper were obtained, or at the rate of 3·21 crude mineral to 1 of fine copper, or 31.1 °/o.

TABLE N.° 5

CLASS OF MINERAL	Weight of same	% of copper in brute mineral	% of silver in brute mineral
1.	98	32·7	0·045
2.	192	27·9	0·054
3.	126	27·9	0·054
4.	70	27·5	0·044
5.	104	25·4	0·057

A somewhat poorer ore extracted from the mine *"Santa Clara"* and *"Grande"*, amounting to 590 quintals, were founded in the Establishment at Pilciau and yielded 169·93 quintals of fine copper or in the proportion of 3·47 to 1, or at the rate of 28·80 °/o of crude mineral treated.

The mine *"Grande"* has yielded mineral which assayed 32·77 °/o of copper and 0·047 °/o of silver with a little gold; but it is evident that these proportions would vary according to circumstances.

On one occasion, 21,975 quintals of copper ore were extracted from the mine "*Grande*", but an analysis of it could not be procured.

Parcels of copper reduced from mineral which had been extracted from the mines "*Santa Clara*" and "*Grande*" formerly realized 13^{s}/3^{d} per unit, and from 50 to 50 $^{1}/^{d}$ per ounce of silver, but this occurred previous to the great reduction in the value of silver; however, it is useful as a comparison to present prices, and we shall refer to it more fully when treating upon metallurgy.

The mine "*Isabel*" is situated at a distance of about 275 yards to the north west from the "*Grande*". The vein of mineral in this mine runs in the direction of north 80° south, and consequently it is expected to cross the vein in the "*Grande*".

Some workings have been carried on in this mine, but there is no evidence when it was done, or by whom. The ore consisted of carbonates of copper, and samples obtained from a deposit, which was found at the surface, assayed from 10 to 12 °/$_{o}$ of copper, and from 160 to 470 ounces of silver per ton.

This vein of mineral is, according to the best evidence, similar in quality to that in the surface part of the "*Grande*", i. e., it contained much peroxide of iron.

The mines "*Bertolina*" and "*Dolores*", are continuations of the "*Grande*"; the same vein of mineral runs through them, and small workings have been made.

One of the branches of the vein of mineral in these mines shows a thickness of 80 centimetres, but it contains iron, which indicates that good copper ores will be discovered in the deep.

The mine "*25 de Mayo*", is situated to the south east of the "*Grande*" and joins it, as also to the south west limits of the

"*Rosario*" mine. At the surface the vein of mineral consisted principally of iron, ranging from 40 to 60 centimetres in thickness. This vein has not been proved to any extent.

The mine "*Rosario*". A part of this mine is joined to the "*Restauradora*" and "*25 de Mayo*", and there is evidence to prove that a large quantity of good copper ores has been taken out of it. From the point where the "*25 de Mayo*" joins the vein in the "*Rosario*", ores have been extracted yielding a large quantity of silver, and, it is reported, that the copper ores occurred in such abundance that 300 men were employed in the mine at one time. The principal vein of mineral in this mine has been exploited to a depth of 250 yards, measured upon the inclination of the vein. The thickness of the vein varied from 8 to 32 inches, and extended horizontally for a distance of 75 yards, and to a considerable depth.

The mine "*Catamarqueña*". This mine is situated to the west of the "*Rosario*", and the mineral vein occurring in it is mixed with carbonate and sulphide of copper.

The works carried on in it were upon a limited scale, but according to historical evidence, the copper ores contained 160 ounces of silver per ton. Samples taken from the spoil-bank assayed at the rate of 9 ounces of silver per ton.

At the surface, the copper veins showed a thickness of 30 centimetres, but when the writer visited this district the mine was closed and the thickness of the copper vein in the depth could not be ascertained.

The mine "*Luisita*" is a continuation of the "*Catamarqueña*", and the vein of mineral existing in it would, doubtless, have similar conditions. Both these mines have been located upon a *gneisic* formation.

The mines "*Clementina*" and "*Laura*". These mines are situated to the east of the "*Rosario*" and it is believed that the same vein of mineral runs from the latter through the former.

The mines "*Petrona*", "*Ernesto*" and "*Salvadora*" are prolongations of the "*Clementina*" and "*Laura*".

The mine "*Salvadora*" was at first exploited by an adit driven in from the side of the mountain. The vein of copper ore runs in a western and eastern direction, with some variations, and inclining towards the south. The ores extracted from this mine consisted of grey, and black oxides of copper, but a change in the class of ores occurred at a depth of 20 perpendicular yards from the surface.

The mine "*Carmelita*" is situated to the east of "*Rosario*", and it is believed that the principal copper vein in the latter passed into the former.

In the high parts of the mountains in this district, exists a place called "Pan de Azucar", the highest points surrounding which is formed of trachyte. A gallery has been driven from the side of the mountain for a length of 226 metres, in the direction of north 55° west, to intersect a vein of mineral which seemed to run in the direction of south 62° west. The gallery or adit referred to, is called "*Porteño*", and from the works carried on in it upwards, it is understood that old workings were discovered.

At the time of the inspection of the "*Carmelita*" copper ore had not been reached; but the evidence to hand proves that afterwards the vein was found and that its thickness varied from 20 to 120 centimetres. The class of mineral contained in the vein consisted of grey and pyrites of copper, mixed with galena, pyrites of iron and sometimes a little blende. The body of the mineral vein contained quartz and ferruginous elements.

Experienced miners in this district, are divided in opinion as to whether the vein of copper ore discovered by the adit *Porteño,* is identical with the "*Carmelita*" or the "*Restauradora*", the vein of mineral in which appears to run in that direction.

All such problems would, however, be definitely settled if proper instrumental surveys were to be made of this district, and, from the data thus obtained construct accurate plans and sections.

However, on account of the difficulty occasioned by the awkward topographical features of this mountain region, and the trouble and expense attending it, such practical and scientific determinations would appear to be a work of the future.

More recent information indicates that the workings carried on in the adit *Porteño*, have occassioned the descovery of two other important copper lodes. This adit is important because, by its means, all the mineral veins above its level could be drained, and also, if it were to be continued it is highly probable that various other copper lodes of importance would be descovered.

The mine "*Maximo*", is situated to the south east of the mine "*Carmen*", and no doubt exists under the same conditions. The southern and south western parts of it is upon a formation of porphyritic and trachytic rocks.

The mine "*Elvira*", is located to the south of the "*Rosario*", and when inspected had not been exploited, but it is almost certain that the rich mineral vein containing gold, silver and copper, existing in the mine "*Argentina*", will run into the "*Elvira*" and, probably, il will turn out to be a rich mine.

The vein of mineral in the mine "*Argentina*" is likely, also to pass through the southern extremity of the "Rosario", and, if continued would be found in the mines "*Laura*", "*Petrona*" and "*Ernesto*".

The mine "*Argentina*" has been previously referred to as having a very rich vein of mineral. It bears nearly east and west, inclining towards the south. The mine has been located upon a formation of decomposed granite, but there has been

two or more pits made upon the vein to a depth of about 14 metres. When the writer visited this district, the lower part of this mine was full of water, but samples of mineral were procured near to the entrance, and the assays made proved that the mineral was very rich in copper, silver and gold.

Some years previous, this mine had been exploited with excellent results. At the depht of 15 metres, the vein consisted of grey copper, pyrites of copper mixed with peroxide of iron, galena and quartz. It is the same class of mineral at the surface as that found in the mine "*Mejicana*".

Some of the samples of mineral, obtained from the upper part of the "*Argentina*", assayed 170 ounces of silver and 2 ounces of gold per ton, but a better class ore from the same mine yielded 340 ounces of silver and 2 1/2 ounces of gold per ton.

The "*Mejicana*", is a mine which may be considered to be continuation of the "*Argentina*", and the vein of mineral passing through it may be seen in a well defined condition at the surface, and consists of peroxide of iron mixed with quartz, with here and there small patches of carbonate of copper. Samples obtained from this vein yielded from 80 to 360 ounces of silver per ton. The thickness of the vein is, in places, as much as 9 feet. An adit has been driven upon, and in the direction of the vein for a distance of 320 yards and, at this level, was of the same quality as described. As was the case in the mine "*Argentina*", so is that in the "*Mejicana*" i. e.; it may be expected that the ores will change and become richer in the deep.

The mines "*Louisa*", "*Arturo*" and "*Albert*", have been located on the same vein of mineral as the "*Mejicana*", and possess the same conditions.

Other veins of mineral exist in the mines mentioned, and run almost parallel with the one coming from the "*Mejicana*". They contain peroxide of iron and pyrites.

The mine "*Ortiz*". This important mine is situated to the north of the "*Restauradora*", and in an elevated part of the cerro of the same name. The vein of mineral runs from the north west to the south east. The surrounding rocks consist of granite, and the copper vein in it is very irregular, but a large quantity of excellent ore has been extracted from it. It consists of red oxide and carbonate of copper, of high percentage. There are several other mines situated to the east of the "*Restauradora*", one of which is named "*Banderita*".

Towards the south of the adit driven into the "*Salvadora*", a mine called "*Tucuman*" is situated. It also bears southward of "*Argentina*", "*Mejicana*" and "*Louisa*". In this district various veins of galena exist, and some little workings have been made upon them. The veins of mineral in this locality have been traversed by eruptive dykes, as is also the case with the vein of mineral in the mine "*Ortiz*". The dyke in question consists of trachyte, and is 9 feet thick. This dyke also passes through the vein of mineral in the mine "*Isabela*". The nature and conformation of this dyke leads one to believe that the copper vein is of more recent formation than the dyke.

A large number of veins of quartz, and other classes, are found destributed through the mountains of Capillitas, and some of these have been tested upon a small scale, which, however, was not sufficient to determine whether such veins of mineral were of value in the depth or not.

The District of Atajo

This district is situated at a distance of about three leagues in a north west direction from Capillitas. The formation of the rocks in that locality consists, for the most part, of decomposed

trachyte mixed with quartz in which there exists a net work of thin veins of peroxide of iron and quartz, which nearly always contain small veins of native gold. These mines were proved to a small extent in 1878, 1879 and 1880, and some samples of mineral were extracted which contained a large amount of native gold; but it does not appear that any large quantity of ore, containing gold, was extracted from the mines.

The vein of mineral which traverses the mine called "*Maria Eugenia*", runs in a north east and south west direction, inclining towards the south, and it has a thickness of from 1 to 1 $^1/_2$ yards.

Sometimes such veins are divided into other smaller ones in a very irregular form. When copper occurs in these veins it consists of grey copper and pyrites mixed with quartz. These mines, however, were not thoroughly explored, much, less worked in the deep at the dates given above.

At a distance of about a league to the west of the mine "*Maria Eugenia*", noted above, exists a mine called "*Descubridora*", which contains a mineral vein yielding copper and silver of high percentage. The direction of the vein is from north west to south east, inclining towards the north and has a thickness of 24 inches, and samples obtained from it have assayed at the rate of 60 ounces of silver and 1 ounce of gold per ton. At the surface, the vein of ore was mixed with porous quartz, with patches of green carbonate of copper and some galena. The walls of the mine consisted of compact granite, and one of the veins of mineral first discovered and traversing it yielded at the rate of 120 ounces of silver and 3·5 ounces of gold per ton.

Up to the 14th. May, 1902, there only existed a single concession or application for a mine of copper in this district upon the provincial Government Register. More recently,

however, all the mines of value in this district have been taken up.

The mine "*Ana María*", situated to the south of the place called Portezuela del Abra del Cerro Bayo, mineral district of Atajo, is being worked by Mr. Antonio Moller.

He has extracted copper ores from this mine which yielded the following elements.

Copper	26·0 %	
Gold	40 grammes	per ton
Silver	12 ounces	

Workings have only been commenced upon a small scale, but the mine promises to yield an abundance of copper ore.

Other similar mines are situated close to those belonging to the Capillitas Copper Company Limited, London. One of these belong to Messrs. Angel Maza and A. Barros. It would, however, seem that this is rather a *Cateo*, or exploration field, than a simple mine. A considerable amount of exploring has been done upon it.

It would, also, appear that many old workings made by the Indians and Spanish exist within the area described.

There are also the remains of old walls, grinding machines, and gold washings found upon or within the limits of this exploration area, proving that mining operations must have been carried on in ancient times to a considerable extent.

It is interesting to note that the ruins of an old church also exists upon the same land, which would seem to prove that some of the mines were worked during the jesuit period.

In the centre of the exploring area noted, several veins of mineral have been discovered, some of which are almost in a virgin condition. Others, however, have been proved by the owners.

The most important lode in the series is the "*Catamarqueña*",

upon which an inclined pit has been sunk, and it is reported that it has a thickness of 15 metres, in which there exist various small bands containing copper, gold and silver.

So encouraging was the yield that the owners commenced an adit at a deeper level and believed that the lode would be intersected at a distance of 35 metres, from the entrance of the adit.

To the north of the mine in question, exists another old gold mine with the remains of gold washings. The mine is called the "*Antigua*", and contanis two lodes, one of gold ore 70 centimetres in thickness, and the other of copper ore also 70 centimetres in thickness.

Between the "*Catamarqueña* and "*La Antigua*", exists another lode containing copper, gold and silver. An inclined shaft has been sunk upon it to a depth of 15 metres, at which point its thickness was proved to be 80 centimetres.

Various other lodes, containing copper, gold and silver in this district, have been worked by the Indians and Spaniards to a depth of from 5 to 20 metres.

The exploring area we have described, and in which so many lodes exist, is the centre of a very extensive mining region which, undoubtedly, will prove of great importance in the future.

Another serie of mines occur in the *Cerro Colorado,* in the same district as that mentioned above, but the writer possesses no special details in reference to them.

As may be seen by the previous description, that much attention is now directed to the *Atajo* mining district, and it is believed that those mines will be taken over, with others, by a syndicate with a view of forming a company for their exploitation.

Mr. Samuel Lafone Quevedo, to whom the writer is obliged for much information referring to this district says: "The *Ata-*

jo ores are rich in copper and gold; but these mines have not been proved so deep as the *Capillitas* groups; the latter, however, improved in the yield of gold in depth, and we may expect the same increase in the *Atajo*". He further adds that if these mines are not sold to a syndicate, "we—Messrs. Lafone Quevedo and Company—mean to start new furnaces and smelt the Atajo ores and hope to avail ourselves of the Capillitas Company's cable road".

It would appear that the London company, referred to, as having acquired groups of mines in the *Cerro* of Capillitas has not yet commenced to open the mines possessed in the *Atajo* district.

The Mining District of Vis-Vis

This district is situated to the south west of the *Atajo* mining district and, recently, other important mines have been discovered in that locality upon the estate which Mr. Samuel Lafone Quevedo possesses there. These mines are being inspected in the same manner as those of the *Atajo*, by the agent of a London Syndicate, and if not taken over no doubt Messrs. Lafone and Company will put them under exploitation.

Mineral District of Campo Grande

This district is situated at a distance of about 3 leagues in an eastern direction from the "*Descubridora*", in the Cerro de Capillitas, and on the western side of the great Cerro de *Aconquija*, and in it various important mines have been discovered. One of these is called "*Descubridora*", which is a common and favourite name for any mine first discovered in any district. The principal vein of mineral in this mine runs

in an eastern and western direction. It has a thickness of 24 feet, and the mineral extracted from it yielded at the rate of 53 ounces of silver, and 1·35 ounces of gold per ton.

An excavation or inclined pit was sunk upon this vein, and at a few yards in depth, the body of the vein consisted of porous quartz with patches of green carbonate of copper and a little galena. At the depth of 15 yards, the yield was at the rate of 104 ounces of silver and 3·5 ounces of gold per ton. It is curious to note, that the central part of this vein carried a thin deposit in the form of fine powder, and from this the large yield of gold was derived, but this auriferous powder terminated downwards, introducing into the vein pyrites and at a depth of 18 yards the yield was at the rate of 39 ounces of silver and 1·30 ounces of gold per ton. The walls of the mine consisted of solid granite.

At a short distance to the north of fhe "*Descubridora*", other veins of mineral of the same class have been discovered.

One of these was called "*Concordia*", and had a thickness of 24 feet; it was crossed by a number of other smaller veins. Samples of mineral from another vein and mine, called "*Constancia*", yielded at the rate of 150 ounces of silver, and 1·65 ounces of gold per ton.

The thickness of this vein varied from 2·3 to 2·9 yards. On the southern side of the "*Constancia*" and at a little distance from it, four other veins of mineral exist, and these cross a larger, one 24 feet in thickness. One of the cross veins has a thickness of 2 yards, and the mineral extracted from it yielded both gold and silver; however, it is mixed with a small quantity of lead and zinc. Another of the cross veins has a thickness of 9 feet, and consists of pyrites of iron and lead.

There are various other veins of mineral in the same locality of great thickness and of the same quality.

The district *Campo Grande*, has a circular form, and at a

distance of about 1 1/2 leagues to the east of it, and at a lower level a large number of mineral veins are found crossing one another, all of which contain the same class of mineral as in those already described. In the same locality a thick vein of lead has also been discovered.

No works of importance have been effected in the mines of this district, consequently it is impossible to judge whether the mines would prove valuable in the deep, or not. It is, however, highly probable that the nature of the veins would change introducing copper, and other metalliferous elements of commercial value. No doubt, this district will receive more attention in the future.

Mining District of Cerro Colorado

Santa Maria

In this district, various mines have been discovered from time to time, but comparative little work has been done in any of them.

In 1883, the writer received a sample of mineral from one of the mines in the district of *Santa Maria* consisting of grey copper, pyrites of copper, etc., and by assay, it yielded a large percentage of copper, silver and gold. It was reported on good authority that the vein of mineral from which this sample was obtained had a great thickness.

It has, also, been reported that a mine of mercury exists in this district, and this has occassioned a long search by interested persons in order to discover it; but the miners are always jealous and, consequently, desire to keep a secret to themselves, and do all they can to impede the action of explorers, as also mislead them as to the locality in which a rich vein of mineral or mine may exist. For these reasons, if the

mine of mercury exists at all its situation is kept as a profound secret.

The regions about the mountains of *Santa Maria* are remote and somewhat difficult of access, and for this and other reasons, a scientific and practical system of exploration has never been officially or otherwise undertaken in this district.

Up to the 14th. May 1892, only one concession of a mine in this district appears upon the official register. This mine is called "*Alianza*", and the vein of mineral runs in an eastern and western direction, and yields silver. Recently, however, a vein of mineral of bismuth has been discovered in this district. Samples of mineral extracted from the mine have yielded at the rate of 9 °/₀ of bismuth.

The Mining Districts of Aconquija, Ambato, etc.

The highest points of the great mountain of Aconquija, which are nearly always covered with snow have, according to the best authorities, an elevation of 5400 metres. Other parts of it do not however rise to more than 4692 metres.

The lowest part of this mountain range has an elevation of 2187 metres above sea level. This mountain is situated to the east of *Capillitas*, and extends for a long distance northwards, or to the division line between this province, Catamarca and that of Tucuman. The mountain also runs southward passing to the east of the town of Andalgala until it becomes united to another great range of mountains called *Cerro de Ambato*, which latter runs southward forming a slow irregular curve westward as far as *Chumbicha*.

These Cerros cover a large area of territory, and the whole is divided at various points by innumerable ramifications, valleys

having different altitudes, and deep gorges which renders travelling slow, difficult and dangerous.

It is an historical fact—see first Chapter—that many parts of the districts in these mountain regions contain a large number of mines of various classes, especially copper, silver and gold; but, as is the general rule in modern times the want of proper explorations, only a small proportion of the mines, which undoubtedly exist there, has been discovered.

It is, however, almost certain that if proper and prolonged geological and mineralogical explorations were to be made by serious and practically qualified persons, some of the ancient rich gold mines of the Jesuits would be discovered, as well as various new ones of different classes. Evidence exists proving that the *Jesuits* worked mines in these regions and obtained large quantities of gold from them.

The Mining District Cerro Negro Aconquija

This district is situated at an altitude of 3000 metres above sea level, and at a distance of 40 kilometres from the town of Andalgala.

Not long since, several concessions of mines were obtained, the principal ones were named "*Irene*", "*Montenegro*", "*Ilse*" and "*Sofia*". These mines consist of 9 *pertenencias*, covering an area of 52·12 hectares.

The formation of rocks in which the veins of mineral are found consist of trachyte. The principal lode is that of "Montenegro", running in an eastern and western direction and inclining 15° towards the north. The other lodes have various magnetic bearings.

The mineral contained in these lodes consists of carbonates and oxides of copper, mixed with oxide of iron, etc., in the whole of which a certain percentage of gold exists.

In 1901, about 30 tons of this copper ore were extracted and smelted at the establishment at *Pilciau*.

Samples of the same mineral were assayed in the laboratory of the National Government Mint, by Dr. J. J. Kyle, and yielded the following elements:

N.º 56

Copper	12 %
Silver.	0·0015 "
Gold.	0·0045 "

or at the rate of 15 grammes of silver, and 45 grammes of gold per metric ton. The workings in these veins are not extensive, but the principal lode has been cut into and found to be 3 metres in thickness without reaching the hanging wall. At the depth reached, the copper ore was found to be richer than at the surface. A gallery has been driven in the side of the mountain for a distance of 45 metres to intersect the lode at a point 16 $^1/_2$ metres below the bottom of the inclined shafts which had been made upon the vein.

There is no evidence to hand referring to the productive qualities of the other lodes, but the owners are convinced that the general yield of gold will be very great and, for these reasons, the persons interested have commenced to erect an establishment of fundition at a place called *El Totoral* in the district of Potrero, about 30 kilometres from the mines and 10 kilometres from the town of Andalgala. It is expected that this establishment will be in a condition to commence the reduction of ores in the month of May of the present year. As soon as possible after this establishment is in a going condition, two other smelting furnaces will be erected, so that it will be a mining centre of considerable importance.

All the surrounding circumstances are favourable so that it

may be expected that considerable profit will be derived from the mining and smelting operations referred to.

The Romay Iron Mining District

To the west of *Recreo*, or the Frias Station, on the North Central Railway, and at about 2 ½ leagues, a series of low mountains exist, and in one of these, called *Sierra de los Altos*, various thin veins of titanic iron ore have been discovered, and some unimportant works placed upon them.

A number of Engineers and Geologists were employed from time to time to examine and report upon these iron mines for interested parties, and, consequently, much public attention was directed to them. The interest thus raised in 1873 continued until within the last 3 or 4 years.

A company called the "Sud Americana" was formed to exploit the mines and smelt the mineral in high furnaces; but before obtaining any practical result, the small amount of Capital raised was lost, and on two several occasions application was made to the National Government for aid.

This resulted in a project of law being introduced into Congress guaranteeing 6 °/₀ upon a capital of 1,500,000 dollars, and although the project became law, the capital indicated was never raised and, finally, the whole scheme was abandoned.

A quantity of this titanic iron ore was founded into three bars in a small establishment in Buenos Aires, and when the writer was commissioned to represent the mining and metallurgicial industries of the Republic, at the exhibition of Chicago, in 1893, he exhibited one of the three bars of iron referred to, as also samples of the titanic iron ore and various analysis of the same, but the jury of awards ignored the value of the iron.

TABLE N.º 6

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
31·815	0·032	—	43·404	0·150	—
31·441	0·064	—	22·952	0·126	-
31·552	0·080	—	51·585	0·000	-
31·774	0·356	—	75·901	10·253	0·0008
31·774	0·106	—	40·900	—	—
41·814	0·126	—	76·356	9·224	0·0016
49·152	0·200	—	76·356	—	—
21·760	0·050	—	77·717	—	—
24·074	0·100	—	27·775	0·152	—
31·232	0·090	—	27·580	0·060	—
34·559	0·130	—	27·108	0·072	—
20·992	0·140	—	27·997	0·076	—
64·710	0·040	—	15·554	0·108	—
5·120	0·050	—	10·665	0·124	—
5·632	0·170	—	35·552	0·244	
28·160	0·080	—	27·552	1·040	—
7·068	0·030	—	49·996	0·136	—
24·576	0·040	—	23·775	0·196	—
8·192	0·050	—	22·664	0·172	—
23·118	0·130	—	40·218	0·028	—
5·632	0·060	—	9·110	0·030	—
15·104	0·204	—	8·888	0·168	—
47·872	0·024	—	7·777	0·048	
53·284	0·028	—	28·663	0·028	
33·536	0·350	—	42·218	0·156	
26·112	0·248	—	30·663	0·116	—
14·089	0·170	—	50·439	0·080	—
28·179	0·092	—	12·443	0·050	—
14·540	0·112	—	0·577	0·072	
—	0·068	—	33·532	0·088	—
11·362	0·140	—	22·220	0·092	—
50·220	0·140	—	33·552	0·192	—
51·585	0·058	—	48·439	0·068	—
38·632	0·080	—	47·995	0·176	—
48·117	0·104	—	26·219	0·108	—
10·908	0·136	—	55·327	0·025	—
48·632	0·132	—	27·352	0·076	—
15·220	1·160	—	31·552	0·028	—

TABLE N.º 7

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
10·226	0·050	—	38·896	0·028	—
5·794	0·154	—	53·550	0·188	—
15·225	0·116	—	22·220	0·372	—
42·495	0·286	—	61·882	0·028	—
8·862	0·120	—	53·772	0·024	—
14 544	0·058	—	46·217	0·040	—
33·405	0·058	—	9·332	0·024	—
33·178	0·000	—	37·107	0·068	—
62·226	0·000	—	35·329	0·040	—
37·650	0·144	—	22·220	0·024	—
33·633	0·084	—	52·439	0·088	—
66·993	0·222	—	23·108	0·036	—

Samples of copper ores selected by the writer from the mine "*Restauradora*", Capillitas, and which formed part of his extensive private collection—the whole of which was lent to the national government to be exhibited at the Exhibition of Paris in 1887, and in Chicago in 1893—were assayed in the laboratory of the then National Department of Mines and Geology, and the elements deduced are represented in tables N.ºs 6 and 7. The copper ranges from 0·577 °/₀ to 77·717 °/₀ and the silver in columns 2 and 4 ranges from 0·024 °/₀ to 10·258 °/₀.

Gold was detected in two of the samples only and was at the rate of 0·0008 °/₀. The classes of ore assayed consisted of *Chalcopyrite, Phillipsite, Grey Copper,* black and red *Oxides, Malachite,* etc., etc.

TABLE N.º 8

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
34·218	0·124	—	19·853	0·160	—
35·107	0·216	—	39·031	0·040	—
20·000	0·080	—	68·460	0·080	—
33·810	0·060	—	26·014	0·124	—
35·022	0·164	—	20·366	0·162	—
23·825	0·136	—	9·403	0·016	—
32·640	0·140	—	32·347	0·188	—
21·204	0·108	—	31·833	0·120	—
23·825	0·016	—	32·689	0·180	
5·956	0·020	—	9·584	—	—
43·838	0·048	—	16·088	0·180	—
12·597	0·104	—	55·452	0·196	
34·546	0·028	—	65·379	0·240	—
30·496	0·072	—	64·694	0·000	—
32·402	0·044	—	40·391	0·180	—
22·960	0·104	—	23·618	0·036	—
25·238	0·024	—	15·403	0 044	—
31·667	0·090	—	14·034	0·176	—
45·953	0·028	—	32·005	0·060	—
17·381	0·040	—	22·934	0·056	—
60·000	0·040	—	19·168	0·040	—
62·144	0·056	—	35·559	0·044	—
54·524	0·040	—	23·270	0·040	—
18·095	0·040	—	15·745	0·040	—
28·572	0·060	—	—	0·040	—
41·667	0·036	—	14·718	0·036	—
32·860	0·060	—	22·934	0·080	—
28·572	0·148	—	16·772	0·000	—
27·610	0·200	—	24·645	0·040	—
73·324	0·040	—	26·669	0·048	—
20·952	0·044	—	18.484	0·036	—
16·190	0·076	—	3·251	0·036	—
19·524	0·036	—	2·902	0·040	—
39·527	0·036	—	13·222	0·040	—
53·810	0·080	—	35·636	0·060	—
48·572	0·040	—	36·281	0·056	—
32·334	0·104	—	19·350	0·000	—
42·371	0·036	—	—	—	—

TABLE N.º 9

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
63·810	0·040	—	24·026	0·040	—
36·667	0·030	—	19·027	0·000	—
45·715	0·040	—	4·192	0·040	—
23·810	0·036	—	25·152	0·000	—
20·195	0·036	—	4·514	0·040	—
19·339	0·532	—	—	0·040	—
17·799	0·036	—	8·546	0·044	—
31·605	0·040	—	13·867	0·320	—
57·677	0·044	—	—	0·072	—
10·970	0·044	—	—	0·280	—
20·538	0·136	—	—	0·160	—
34·743	0·160	—	—	0·044	—
28·753	0·232	—	—	0·060	—

The samples of copper ores from which the elements in Table N.ºs 8 and 9, were determined, were obtained by the writer from the mine "*Grande*", to which reference has been previously made, and also form part of his general collection, previously referred to.

The percentage of copper exhibited in these Tables, ranges from 2·902 °/₀ to 73·324 °/₀ and the silver in columns 2 and 4, ranges from 0·018 °/₀ to 0·532 °/₀. These samples contained no appreciable quantity of gold.

TABLE N.º 10

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
—	0·056	—	24·476	7·61	-
0·322	0·028	—	12·619	0·33	—
—	0·028	—	23·095	0·92	—
0·123	0·030	—	23·810	0·92	—
4·192	—	—	59·525	0·56	—
32·250	0·256	—	19·048	0 64	-
3·870	0·040	—	45·715	0·82	—
42·891	0·180	—	13·809	0·59	—
34·507	0·028	—	11·190	0·24	
13·545	0·028	—	25·476	0·204	—
5·643	0·400	—	25·238	0·290	—
1·935	0·300	—	4·523	0·190	
24·026	0 600	—	23·144	0·680	
9·675	0·188	—	25·788	1·70	—
15·480	0·038	—	32·349	0·69	
14·028	0·098	—	6·135	—	
7·417	0·090	—	11·589	—	—
14·028	0·040	—	6·817	1·853	0·0006
13·222	0·094	—	8·408	—	—
15·157	0·038	—	18·634	4·889	0·0030
4·837	0·040	—	29·876	—	—
1·773	0·050	—	9·731	1·088	
2·580	—	—	12·098	1·234	
3·870	0·164	—	42·080	3·480	
—	0·020	—	23·933	3·720	
33·540	0·280	—	41·028	2·988	
10·390	—	—	11·572	—	—
21·930	0·060	—	6·732	0·034	
50·995	0·030	—	7·364	0·716	—
—	0·028	—	3·945	2·356	
11·932	0·030	—	42·080	0·680	
1·290	0·020	—	20·770	8·760	
8·062	0·100	—	20·251	1·404	
15·802	0·090	—	19·725	0·420	
1·773	0·052	—	8·153	2·250	—
12·900	0·340	—	44·184	0·980	—
18·566	0·040	—	29·350	1·958	—
17·576	0·040	—	9·468	2·490	—

TABLE N.º 11

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
27·727	0·256	—	10·783	2·160	—
—	0·020	—	28·881	0·370	—
—	0·020	—	25·788	0·754	—
4·837	—	—	27·352	0·058	—
40·960	1·020	—	26·140	0·400	—
12·143	7·860	—	35·510	3·356	—
14·286	0·980	—	30·508	10·180	—
37·857	0·820	—	49·970	1·108	—
30·476	0·380	—	45·920	—	—
31·429	1·510	—	42·500	—	—
41·429	6·850	—	57·334	0·402	—
22·857	0·750	—	—	7·876	—
9·199	0·060	—	9·888	9·148	—
22·881	1·626	—	14·991	0·292	—
0·783	4·560	—	11·490	0·568	0·032

The assay determinations in the above Tables N.º 8 and 9, were made in the same manner as described for those in Table N.º 6, and represent the mineral samples as taken in a more general manner, and cannot be considered to be the best samples selected.

The copper elements, represented in these table, N.os 10 and 11, ranges from 0·028 °/₀ to 59·52 °/₀, and the silver in columns 2 and 5, from 0·020 °/₀ to 10·180 °/₀.

TABLE N.º 12

Copper %	Silver %	Gold %	Copper %	Silver %	Gold %
—	0·672	—	—	0·496	—
3·00	0·028	—	—	0·152	—
0·00	0·022	—	—	0·738	—
0·45	0·242	—	—	1·050	—
—	1·760	—	—	0·170	—
—	0·032	—	—	0·140	—
6·40	2·106	—	—	0·288	—
3·70	1·842	—	—	0·196	—
0·75	1·020	—	—	0·088	—
0·40	0·154	—	6·30	5·220	—
—	0·050	—	—	0·060	—
2·70	1·260	—	0·10	0·086	
—	0·336	—	—	1·920	—
0·45	0·132	—	—	0·032	—
—	1·418	—	—	0·252	—
—	0·440	—	—	1·090	—
4·25	4·046	—	—	0·034	—
2·90	1·380	—	—	0·189	0·018
9·00	6·332	—	—	1·180	
3·25	2·580	—	—	0·062	—
3·15	1·696	—	0·30	0·448	—
0·30	0·232	—	14·50	0·078	0·038
0·60	0·480	—	30·00	0·022	—
5·75	0·044	0·014	—	0·032	—

The metalliferous elements contained in the above Table N.º 12, were determined from some of the most inferior classes of mineral which enter into the selection of that which is treated in the reduction furnaces. It ranges from 0·10 °/₀ up to 30·00 °/₀, or the maximum which, however, is a solitary example in the Table.

The silver in the columns of the Tables number 2 and 5, show well, and ranges from 0·022 °/₀ to 5.22 °/₀.

In this serie of assays, gold was detected only in two of the samples, and was at the rate of 0·018 to 0.038 °/₀.

TABLE N.° 13

Copper %	Silver %	Copper %	Silver %	Copper %	Silver %
49·76	0·016	52·88	0·005	27·88	0·088
30·72	0·018	44·61	0·004	11·83	0·122
34·28	0·168	43·41	0·042	—	0·040
40·72	0·116	4·57	0·084	—	0·028
70·91	0·003	10·19	0·188	3·71	8·030
61·34	0·003	9·62	0·320	—	0·034
54·08	0·016	28·60	0·060	61·54	0·278
27·64	—	35·09	0·096	16·63	0·030
32·69	—	16·63	0·062	—	—
20·19	0·007	43·46	0·182	—	—
59·32	0·018	4·04	0·098	—	—

The assay elements, exhibited in the Table N.° 13, were determined from samples of Copper ores collected from the mines in the Cerro de Capillitas, and found part of the general collection which the writer was commissioned to exhibit at the Paris Exhibition, 1889, and at that of Chicago in 1893. These samples were selected, and do not represent the average product of any of the mines described in that district. The copper elements range from 3·71 °/₀ to 61·54 °/₀, and the silver in columns 2, 4 and 6 is at the rate of 0·0036 °/₀ to 0.278 °/₀.

Up to May 1902, the provincial government register indicated the following concessions of mines.

Silver	8	concessions
Silver and copper	3	"
Coal	7	"
Copper	3	"
Iron and copper	1	"
Iron	1	"
Gold and silver	1	"
Bismuth and silver	1	"
Copper, silver and gold	4	"
Antimony	1	"
Galena	2	"
Lime	3	"
Borate of lime	1	"
Gold	4	"
Mica	1	"
Sulphate of iron	1	"
Total	42	concessions

These mines are distributed in the various mining districts, the greater number of which have already been described.

The most recent discovery, as previously noted is the mine of Bismuth situated in the Cerro de Aconquija, district of San Jose.

Samples of this mineral were assayed in the National Government Mint of Buenos Aires by doctor J. J. J. Kyle, and was found to yield at the rate of 9·86 °/₀ of bismuth, with traces of gold.

The new Capillitas Copper Company, formed in London some time since, has purchased a group of 43 *pertenencias* or mines in the district of Capillitas as, also, another group of 6 mines in the Atajo district, situated at a distance of about 9 kilometres to the west of Capillitas.

As has been previously observed, the mines in the Capillitas district were exploited for many years by Mr. Samuel

Lafone Quevedo and others. Workings were carried on upon 12 distinct copper lodes which yielded large quantities of copper mineral.

The new company can command a capital of £ 600.000, and it has commenced to develope the mines in question; but it is natural to suppose that it will take a considerable time before the mines can be placed in a condition to yield a maximum supply of ores.

Nevertheless, for the first six months in 1903, the mines yielded 810 tons of mineral, assaying an average of 14·88 % of copper: from 0·05 to 0·22 ounces of gold, and from 8·05 to 23·48 ounces of silver per french ton; but this can only be considered as the minimum yield for the reason that the lodes have not yet been reached in the deep by the adits now in progress.

When this work has been effected the yield of copper, gold and silver will be much higher.

It is intended to erect a new Establishment of Fundition nearer to the mines than the present one at Pilciau.

An *Aerial-Rope-way* will soon be built, in five sections, from the mines to the new establishment of fundition.

Its total length will be 25 1/2 kilometres, and the difference of level between its extreme points amounts to 1787 1/2 metres. It will have a carrying power of 300 tons per day; but, for a considerable time to come, the company does not intend to transport more than 100 tons per day which will be sufficient for reduction in the two Water Jacket Blast furnaces which have a capacity of 50 tons each.

The Rope-way in question will deliver the ore from the mines to the establishment of fundition.

The *Aerial-Rope-way* will reduce the cost of transport to a considerable extent, giving the company greater advantages in point of speed and profit.

At present it takes 7 mules to convey 1 ton of ore from the mines to the old Establishment occupying 7 days in the return journey, costing 16·66 dollars per ton.

The water power at Huasan, on the river Andalgala, will be utilized for transmitting an electric current to the smelting establishment, the distance being 14 kilometres, where it will be employed as motive power and also for giving motion to the *Aerial-Rope* transporting line. It is calculated that the river Andalgala will yield 215 horse power.

From what has been advanced, it is evident that the company in question will introduce new life into this part of the province of Catamarca, and, no doubt, the energy exerted and the great success which will necessarily follow, will induce the formation of other companies for the object of exploiting other groups of copper mines existing in other parts of the province. In point of fact, at the present moment the representative of a London syndicate is actually examining copper mines for the object indicated.

CHAPTER VII

Mines and Mining in the Province of Tucuman

This province is situated between the provinces of Catamarca, to the south, south west and west: Santiago del Estero to the east, and by Salta to the north. It is also very irregular in form, extending over an area of 23,1124 square kilometres, and is the smallest of all the provinces.

The great chain of mountains known as *Aconquija* and that of *Animas*, divide a part of this province from that of Catamarca, for a long distance in a north west direction, or to a point nearly opposite to Santa Maria. The boundary line of Tucuman then curves and passes westward to Saladillo, in the Cerro de Quilmes; it then follows the Cerro del Cajon, northwards to about 26° 16' south latitude. It then returns eastward passing a little to the south of Tolombon which is 1700 metres above sea level. The part of Tucuman just described is a projection westward, enclosing the ancient mountainous mining district of *Quilmes*, which is a continuation northwards of the mountain chains of *Santa Maria;* in the province of Catamarca. These mountain chains are in the same general line as those of Capillitas, being divided by the large camp of Santa Maria.

According to the writers map of this Republic, the Nevado de Aconquija, is situated in about 27° 5' south latitude, and 66° 5' west longitude. It is also marked on the map as having an altitude of 4630 metres above sea level. These mountain chains cover a very large area of the province.

The capital, Tucuman, has only an altitude of 450 metres, and the Station Trancas, at the northern part of the province has an altitude of 800 metres. The distance between the two places is about 13, leagues in a direct line, and the difference of level amounts to 337 metres.

The Cerro de Medina, is situated to the east of the Tucuman valley, or low level lands and extends from Timbo, 600 metres of elevation, northward to San José. This series of mountains also cover an extensive area of land. As is the case n all the mountain regions of this Republic; the chains of mountains under consideration, are divided into various groups and innumerable ramifications at different heights, as also profound gorges joining the larger mountain masses together.

Naturally the more elevated places in the mountains are exceedingly cold in the winter season, and, consequently, much snow is gathered there: when this melts and the rainy season commences, the various mountain streams feed the low level rivers, forming torrents rushing down at great velocity. For these reasons Tucuman is one of the most favoured provinces in the Republic in respect to water supply: the province is, therefore, one of great fertility and celebrated for its immense forests of timber, etc.

According to reports, the formation of the mountain regions chiefly consist of granite, gneiss and others. The writer has dwelt upon a description of the topographical features of the mountain regions, more than, perhaps, may have been necessary, in order to show that the general formation is similar to that in other provinces where so many mines of various classes

of mineral exist, and, consequently, we are justified in stating that there is no reason why a large number of profitable mines may not he discovered and exploited in this province.

Tucuman was founded in 1653, 19 years before Salta, and consequently the residents there at that period would have enjoyed the confidence of the various tribes of Indians which formed the greater part of the population. The Spaniards must, therefore, have been aware of the position of such rich mineral veins as had been discovered by the Indians. Independent of this, we are aware that in the Sierra de Quilmes, situated to the west of Santa Maria, mineral veins of great importance, rich in gold, silver and copper, once existed.

In 1865, Graty wrote that the Indians exploited the mines of *Quilmes,* and that the Spanish authorities of Tucuman imposed heavy contributions upon the Indian miners and, for this reason, the mines were abandoned. The same writer says.

In a place called, *Huaschascienega,* which is generally supposed to be the same as *Guaschaya,* situated in the Department of Trancas, various ancient mines, rich in silver and antimony existed, and that the body of the veins consisted of felspar, quartz and mica. This author further states that in former times various persons were induced to ask for and obtain "a large number of mines". It also appears that the mines called "*San Francisco*" and "*San Antonio*" were included. It is further added that ancient mines existed in the mountains of *Aimcha,* in the Department of Trancas and that these mines were worked to a certain depth and then abandoned, but no reasons have been assigned for this. It is, however, highly probable that water infiltrated into the mines.

Colalo, is also situated in the Department of *Trancas* and on the eastern declivity of that part of *Quilmes* in this province: it is also reported by Graty that to the "east of that place rich mines of silver were discovered as, also, a thick

vein of iron ore, capable of yielding an abundance of ore". This ore yielded at the rate of 80 °/₀ of metal and appeared to have consisted of olegistic iron ore.

The same author, who had directed much attention to the mining districts of this Republic, states, that at a place called *Aimada* various mineral veins containing carbonate of copper were discovered, and that assays of samples yielded at the rate of 30 to 40 °/₀ of copper. He, also, confirmed the existence of gold and silver mines in the same district.

N.º 1

CLASSES OF MINERAL	Copper per cent	Silver per cent	Gold per cent
1. Carbonate and silicate of copper	38·41	0·0230	0·0005
2. Green carbonate.	30·20	0·0050	—
3. Oxide and green carbonate . .	40·10	0·0126	—
4. Green carbonate.	15·20	—	—
5. Do. Do.	18·54	—	—
6. Auriferous quartz.	—	0·0156	0·0016
7. Do. Do.	—	0·0166	0·0023
8. Do. Do.	—	0·0113	0·0016
9. Do. Do.	—	0·0183	0·0020

The samples of mineral N.ºs 1, 2, and from 6 to 9 were presented by Colonel Don Lucas A. Cordoba, the Governor of the province, and those numbered 3, 4 and 5 were presented by a miner who had received them from the same province. The veins from which they were obtained were represented to be thick; but the position where they existed was not given.

The assays represented in the Table N.º 1 are sufficiently good as regards percentage of copper contained in the samples, and althongh the silver in N.ºs 1, 2 and 3, is not high, still, it is sufficient to encourage the hope that a large sam ple taken

from the veins would give a high yield. Gold occurs in N.º 1 sample only.

The samples of auriferous quartz from 6 to 9, contain gold and silver, the highest yield amounting to 6·4 ozs. of silver and 0·71 ounces of gold per ton. The samples referred to had a ferruginous character and were evidently obtained from the surface part of the vein which had been exposed to the action of the atmosphere for many centuries and, for these reasons, part of the gold may have been disintegrated as is frequently the case. There is, therefore, reason to infer that in depth these auriferous quartz veins would yield a larger percentage of gold and, if they are sufficiently thick and all the surrounding conditions favourable, a profitable exploitation may be carried on. These indications are, therefore, sufficiently encouraging to give impulse to those desirous of carrying out explorations on a large scale in a new camp.

If such explorations were properly conducted by experienced persons, and continued for a sufficient length of time, no doubt a re-discovery of the ancient gold and silver mines, previously referred to—see 1st. Chapter—as, also, various new mines of commercial importance would be found.

This was the opinion expressed by the writer in the chapter which he devoted to this province in his larger work of 1889; but its importance has escaped the attention of the public.

Nearly the whole of the mining provinces of this Republic have been ran over by adventurous persons and others seeking mines for speculative purposes and company negociations; but the province we are now considering has been completely neglected.

We may, therefore, refer this indifference, in a great measure, to the fact that no one in modern times has undertaken a preliminary formal exploitation of the known veins of mineral, so as to determine their value as a commercial undertaking.

This is an unfortunate circumstance, still, if any thought had been given to the subject, which is doubtful, it may be readily seen that it is more difficult to form a mining syndicate, or float a company to exploit virgin mineral veins, although they may have great promise, than it is when a mine, worked for many years, is in question. This is a sufficient reason to explain why speculators have not found the province of Tucuman an encouraging field for their mining operations.

The present Governor of this Province, Colonel Don Lucas A. Cordoba, is exceedingly intelligent in questions of mines due to the practical experience he acquired in the copper mines and establishment of fundition in the province of *La Rioja,* and it is certain that he would join in the writer's regrets that more attention has not been given to mining enterprise in his province. This state of affairs can only be effectually remedied, as previously noted, by forming a commission of experienced mining Engineers to carry out systematic explorations upon the ground itself, with sufficient resources to effect years of practical work; but, such an important expedition should never be entrusted to young men without any practical experience and whose chief reccommendations consist in obtaining an official position and a salary.

Enquiries made to the Governor of this province in 1902 referring to the mineral resources and geology of this part of the Republic elicited the reply that, with the exception of 2 quarries situated in the Department of *Burruyacu,* 1 in that of Trancas, and 3 others in Tafi, no mines were under exploitation. He added that it was known that a large area of slate, probably of silurian age, existed between the rivers *Ceibalito* and *Payo-real* in the Department of Trancas. The Governor concluded his report by stating that quarries of alabaster and marble as, also, that precious metals existed; but the position of these was unknown. This report, also, contains the notice that at

Vipos, upon the estate of Mr. Garcia, in the Department of Trancas, a deposit of sulphate of soda exists.

In an official publication treating of the history and natural resources of this province, in the possession of the writer, sometime since, and in a short notice upon the mines, some assays of silver mineral are given. The yield in one case amounted to 30 per cent of silver, and the class of mineral is described as being Ruby or *Rosicler* silver. There is, however no evidence proving from what mines, or from whence the samples were derived. The writer has not, therefore, reproduced the assays. It is reasonable to infer that if such mines of silver had been discovered in modern times, capital could have been found for their exploitation. Nevertheless, some other reasons may have existed to prevent public attention from being directed to the question and, as we have already proved that rich mines of gold and silver once existed and were exploited by the ancient miners, there could not exist any reason why, at sometime or another, such a mine of silver as that from which the samples of mineral were extracted, may not have been hit upon by some wandering Indian or shepherd, the site of which may afterwards have been forgotten or lost. Such cases have frequently occurred to persons who were not miners or capable of recognising a place of difficult access a second time. Such difficult conditions in the mountains of Tucuman are sure to present themselves.

CHAPTER VIII

Mines and Mining in the Province of Salta

This is a very important mining province, extending over an area of 161,099 square kilometres.

In the 1st. chapter of this work, we have spoken at considerable length upon the ancient mines and mining carried on in this part of South America by the Indians and Spaniards, and from what has been advanced it is to be regretted that we are obliged to admit that taking into consideration the great difference which existed in the ways and means at that remote period, as compared to the present, more attention was then given to the mining and metallurgical industries than in more modern times.

The geographical situation of this province, and the peculiar geological formation of the rocks, are conditions which greatly favour the idea that mineral riches exist; but from what we know of the actual mining which has been carried on, we are justified in stating that it is highly probable and, in fact we believe, that future mining will render this important region, one of the most important in the Republic. Its close proximity to Bolivia, in the southern part of which Republic, in which exist the *Huanchaca* mines,—some of the richest

in the world, — leads one to the conclusion that between that place and the northern part of the province no great difference could exist in the conditions necessary to produce various rich mines.

Some geologists, engineers, and other scientists of great reputation and experience, have formed the opinion that such mineral districts as may be found near to the equatorial regions, would be more likely to produce an abundance of mineral riches than those situated nearer to the Poles. We cannot, however, enter upon philosophical enquiries and speculations or assign reasons in *pro* or in *contra* for such opinions in this place, but propose to refer to it again in the chapter which we may write upon the geology of this Republic. Nevertheles, the practical result is that such opinions seem to be confirmed by the fact that Peru and Bolivia are countries which have always been recognised as being among the richest in mineral wealth in South America and, for these reasons and those previously assigned, the province of Salta, should possess similar conditions.

The most important mining districts in this province are reported to be: 1st., *Payogasta*, or *Poma;* 2d., *Molinos;* 3rd., *San Carlos;* 4th., *Cachi;* 5th., *Iruya;* 6th., *Oran;* 7th., *Metan;* 8th., *Anta;* 9th., *Rivadavia;* 10th., *Salinas de Salta.* Nevertheless, mines exist in other parts of this province.

The following are a few of the mines of note which have been conceded by the government.

The mine Chacabuco. This mine is situated in the northern part of the province, in the Department of Iruya. The mine in question has been worked upon a limited scale on two or three occasions but consequent upon the small amount of capital employed its exploitation could not be continued. The lode consists of gray copper and pyrites carrying gold and silver.

Large samples of mineral have been extracted yielding from 10 to 50 per cent of copper, with silver and gold.

Mineral Districts of Acay

The *Nevado of Acay* is situated at a distance of about 85 kilometres in a north western direction from the town of Salta, as it is represented upon the maps constructed previous to the settlement of the limits of the National Territory of the Andes. The Nevado de Acay has been estimated to have an altitude of 4900 metres above sea level, and from it extend, towards the south east and, also, east and west, various other branch mountains under other names which may be verified from a good topographical map of the province. The whole of these elevated regions cover a very large area, and in some of the lower parts of the ramifications of *Acay* are to be found the rivers Saladillo, Blanco and Negro Muerto which pass through some of the populated localities of Poma, Cachi and Molinos, and into the Calchaqui Valley. The river Blanco passes over a region in which many abandoned mines exist, and, as it may be supposed, the water is very impure due to the presence of the salts of copper, antimony, lead and other deleterious elements.

In the places where the river Blanco and other streams enter the principal current, which descends into the valley, various samples of mineral containing copper, gold and silver, have been found from time to time.

These had been disintegrated from the principal veins which existed high up in the mountains and transported to the lower levels in flood time.

Some of the mines in this neighbourhood have been exploited, as previously noted, but there is no evidence to show how much mineral was extracted. The class of mineral contained in the mineral veins in this neighbourhood consists of

pyrites and other classes of copper and, assays of some samples yielded.

N.º 1

Copper.	20 °/₀	
Silver	220·0	ounces per ton.
Gold.	0·5	

Selected samples from the same neighbourhood, have yielded as much as 60 °/₀ of copper.

Nearly on all sides of the small streams of water falling down from the depressed places and deeper gorges of the mountains of *Acay*, may be seen the remains of mine workings belonging to a remote period.

Some of the mineral veins which were worked at a small dlstance above the level of the Rio Blanco, contained red oxide of copper, mixed with pyrites of iron, and samples obtained from the veins have yielded by assay:

N.º 2

Copper, from. . . .	20 to 50 °/₀	
Silver "	108·0 " 220	ounces per ton.
Gold "	0·7 " 0·9	

The general opinion is that rich mineral deposits exist in this district capable of yielding large quantities of copper ores, in fact, history confirms that, at one time, the Spaniards employed 300 men in the mines of this locality; but the workings at that period were limited more or less to superficial deposits, and in no case did they reach a greater depth than from 30 to 40 metres.

Some of the mines in this district have been obtained under concession in more modern times and three of the most

noted were named "*Milagro*", "*Mercedes*" and "*Rosario*". The principal vein of mineral in the mine "*Milagro*", runs in an eastern and western direction, inclining towards the north.

In some of the other mines in the district of Acay, the mineral lodes run in the same direction. For the most part the mines are distributed in the mountain ramifications to the south of the *Cerro Nevado*. The mineral found in various lodes consists of red oxide and sulphide of copper, carrying a large percentage of silver. As may be anticipated, the amount of copper and silver, as also gold contained in the mineral lodes, vary to a considerable extent. However, assays of samples, taken from some of the lodes, have yielded:

N.º 3

Copper.	15	to	25 °/₀	
Silver	140	"	250	ounces per ton.
Gold.	0·5	"	0·8	

The mineral lodes in the mine "*Milagro*" exist in granite rocks, but there are various cross lodes passing througth trachyte rocks. Some of the veins have been measured to be from 2·5 to 6 feet in thickness. In the same locality, lodes containing copper and galena exist, but these have not been proved to any great extent. A number of other lodes are known to traverse this district in all directions and still remain in a virgin condition.

The mine "*Mercedes*". The lode in this mine also runs in an eastern and western direction, and consist of oxide of iron, called *paco* by the natives, containing a considerable quantity of silver. When this mine was last inspected, it contained a large amount of mineral at sight.

The mine "*Rosario*". The body of the lode in this mine consists of quartz in which sulphide of silver predominates.

Other lodes of copper and pyrites of iron, with a large percentage of silver, have been traced in this mine. The old workings are still open for inspection.

Various other mines exist in the districts under consideration, but they are more or less of the same nature and exist under similar conditions as those already described.

It has been reported that, not many years since, two companies were formed to work the mines of *Acay;* but, as is generally the case in this country, with too small a capital to render effective the exploitation undertaken.

It is not to be expected that mines situated in such remote places could be exploited with much advantage without adequate capital, aided with facile and cheap transport.

The Mining District of San Antonio de los Cobres

The central part of this district is situated at a distance of about 24 $^1/_2$ leaques in a direct line to the north west of the town of Salta. Formerly it formed part of that province, but, recently, it has been selected to form the capital of the National Territory of the Andes. The highest point in this locality has been estimated at about 3700 metres above sea level.

This important mining district is divided into three distinct parts, or mining regions. 1st. *Qebradas de las Minas,* or *Cabi,* 2nd. *San Jerónimo,* and 3rd. *Los Cobres.*

The mine "*Concordia*". This important mine is situated in the lower part of a branch mountain called *Cerro Bayo,* in the department of *Poma.* The height at which the mine is located has been calculated at 4650 metres, above sea level and, consequently, during the winter season heavy falls of snow occur.

As previously indicated in the first chapter, this mine was worked to a considerable extent by the Spaniards.

A section of the mine, made in 1892, exhibits an old pit, which had been sunk to a horizontal galliery, of 25 metres and, also, that the level galliery had been driven from it in opposite directions, the whole length of which measured 260 metres. It would seem that the attention of the ancient miners was more directed to the extraction of the richer portions of the mineral vein, leaving the poorer ones intact.

One of these rich bunches of ore extended below the lower level, or galliery, to a depth of 25 metres, running for a horizontal length of 25 metres. Several of such rich deposits of ore were worked in various parts above and below the adit or galliery referred to. The other exploring gallieries were numerous; but considering that many of the old workings were in a ruinous condition, it was impossible to obtain data of the extent of the ore mined.

Considering that at that period so many other mineral veins were discovered at the surface, from which ores could be extracted at a cheaper rate, it is quite possible that this was the reason why the works in the "*Concordia*" mine were suspended by the Spaniards.

There is no information to hand referring to the length of time the mine remained neglected, but we know that about 1885-7, Mr. Marcos Amar commenced to open up the old workings, expending his own capital in proving the value of the mine. Afterwards he was joined by some capitalists in Salta, and the workings were continued. However, it would appear that the works conducted in the mine consisted of exploring headings with a view of opening up a large quantity of ores at sight, but the bulk of the ore was not extracted, consequently the whole of the capital subscribed by "La Compañia Minera Argentina", with which Mr. Amar was associated, was exhausted and the works in the mine suspended.

The mines forming this group were visited by engineers on several occasions and reports made upon them showing that they possessed great commercial value.

Samples of the ore were assayed by several chemists including some specialists in London and also by Doctor J. J. J. Kyle, chief of the Laboratory in the Government Mint of Buenos Aires.

Many of these samples came into the hands of the writer, and these were assayed in the laboratory of the National Department of Mines and Geology with the following results.

N.º 4

MINES	Copper %	Silver %	Gold %
"Concordia"	10·470	0·980	0·001
»	11·800	1·013	—
»	10·740	1·135	—
»	9·990	1·120	—
»	10·100	1·190	—
»	9·520	2·620	—
"Libertad"	14·280	1·450	—
»	16·550	1·522	—
»	16·870	1·219	—
"Progreso"	12·000	0·531	—
»	18·500	0·721	—

Other samples of minerals from the same mines were assayed and gave the following results.

N.º 5

MINES	Copper %	Silver ounces per ton	Gold ounces per ton
"Progreso"	10·60	67·50	1·00
"Libertad"	9·00	70·00	2·50
»	12·50	65·00	2·00
»	15·40	80·00	1·50
»	21·00	110·00	1·58
»	5·50	82·00	1·75
»	9·50	73·00	3·00
"Concordia"	18·50	192·00	—
»	19·00	228·00	—
»	26·00	265·00	—
»	24·50	278·00	—
»	6·00	153·00	—

Afterterwards Mr. Marcos Amar introduced the mines "*Concordia*", "*Libertad*" and "*Progreso*" to some London financiers, resulting in the formation of a syndicate to take over the mines from the Argentine Company which Syndicate was registered on the 5th. of February 1896.

After the mines had been reported upon and much delay occasioned, a formal company was registered on the 14th. September 1899, under the title of "Concordia Consolidated Company Limited", with a capital of £ 150,000.

Possession of the mines was obtained and works commenced and continued for some time but the management would seem to be inadequate, resulting in the loss of much time and capital without adequate returns. The London Directors found it necessary to change the management, and, on this occasion, expensive machinery was sent from England and installed at the mines. It seems that under this management considerable sucess was achieved: still, some difference of opinion existed between the members of the Board in

London and, consequently, it was decided to send out a controling agent, and it is reported that this gentleman upset the good management which had been instituted at the mines, causing the resignation of the managing mining Engineer.

The company incurred some small debts which were not regularly paid, and the creditors, taking advantage of the circumstances, instituted law preceedings which resulted in the collapse of the company. Recently the machinery at the mines, which cost, probably, £ 10,000, was sold to an interested party for the sum of 1500 paper dollars.

Whether this company was unduly pressed for payment when they had no funds in the country in order to bring about a general collapse, is a question; but one would suppose that if the whole of the capital sum of £ 150,000 had not been exhausted, the company would have provided for their liabilities.

This group of mines is important and of great value as has already been proved and, no doubt, if a sufficient amount of capital were to be economically expended, good results would be obtained.

Since the Territory of the Andes, or *Puna de Atacama* as it was originally styled, came into the possession of the National Government, San Antonio de los Cobres has been constituted the capital of that territory and, consequently, the group of mines we have discussed has passed from the jurisdiction of the provincial government of Salta to that of the Nation.

The mines in question, therefore, will be granted with a perfect title and under a more permanent protectorate than that of a province.

The mine "Constancia". It has been reported that this mine contains a mineral vein no less than 15 metres in thickness: its principal contents consist of iron pyrities, mixed with copper and silver ores. It has been proved to a small extent, but it is not known how much of the vein is metallised.

The mine "Santa Fe". This mine contains a vein of galena, mixed with antimony and arsenic, but no extensive workings have been carried on in it. Near to this mine, several other lodes, of a similar nature have been discovered.

The mine "Julia". Works have been carried on in this mine to a depth of 30 metres, but there is no evidence present regarding its productive qualities.

Another mine called "*Victoria*", has been located not far from those previously described, and the veins of mineral contained in it are of a similar class.

The second group of mines, "*San Geronimo*", is situated about 3 leagues to the west of the *Quebrada de las Minas*.

The mines located there are "*Restituta*", "*Andaclo*", "*Catamarqueña*", "*San Geronimo*", "*Colombiana*", "*Fortuna*" and "*Alicia*".

Most of the mines contain veins of galena, yielding a greater or lesser percentage of silver, but they have not been proved to any great extent.

The mine "Alicia" contains a vein of antimony yielding from 10 to 40 % of that metal.

In this district also exist other mines, such as "*Pomena*", "*Franciscana*", "*San Nicolas*", "*Teresa*" and "*Guttenberg*".

It has been reported that the veins of mineral in the mines alluded to consist of galena yielding as much as 105 ounces of silver per ton. Various other mines of a similar class have been discovered, and tested, in this district.

The third group of mines is situated to the north of San Antonio. One of the principal of these contains copper lodes of from 0·40 to 0·60 centimetres in thickness.

Mineral obtained from them has assayed over 30 % of copper: however, considering that the veins in question contain iron and copper pyrites in variable proportions, the average produce of copper would be less than that given.

Ancient mines exist at a distance of about 100 metres from the entrance to the mine of copper we are now discussing and It is known that these old mines were worked to a depth of 45 metres, it being curious to note that near to the old mines remains of an old reverbatory furnace have been discovered.

Various other mines containing copper lodes also exist in this district.

To the north of the *Cerro de Acay*, a noted mine called "*Eolo*" was located, in which exists a vein of copper ore mixed with oxide of iron and blende, but the writer has no information as to its capacity of yield.

In the same locality other similar veins of mineral exist upon which excavations were made in ancient times to a depth of 30 metres. A number of others have been examined but not proved.

Extensive areas of auriferous sands have been worked in ancient times in the district of San Antonio. These sands are estimated to extend over 28 square leagues, and there is evidence that the Indians extracted gold from these places by the rude means then employed.

In the Department of *Cachi* extensive ancient gold washings have been discovered extending to the level of the streams passing trough the *Calchaqui Valley*, and gold dust is still collected by the Indians in these districts. Two ancient adits are also known to exist in the Department of *Poma*, and there the gold was found to exist in larger particles, leading the miners to believe that veins of mineral containing gold must have existed and, probably, still exist in the higher regions.

It has been previously noted that numerous samples of mineral containing copper, gold and silver have been found in low level places, especially on the sides of the streams, and from their general aspect and rounded form, it is evident that

such samples of mineral had been transported a long distance, which circumstance leads one to infer that a large number of mineral veins may yet be discovered. Such mineral veins may be looked for in the Departments of *Cafayate, Chicoana, Valley de Lerma, Serranias de Salta* and *La Caldera.*

The depth already reached in some of the mines of *San Antonio de los Cobres,* is not sufficient to prove the riches that may be expected from them, and the various veins which have not been exploited; but the "*Concordia*" is a good guide in this respect. Considering, as previously noted, that there could not exist much difference between the geological formation of these regions and those of Bolivia, a general opinion has been formed that the mineral of the mine "*Concordia*", and others in the San Antonio district, is similar in character to that obtained from the renowned mines of *Huanchaca.* We are, therefore, justified in inferring that the group of mines in this district will prove of great importance in the future.

On the north west side of the *Quebrada de Acay,* and at about 1 league from the place called *Orgamello,* extensive ancient gold workings are to be found, and there is evidence that the auriferous mineral which had been treated was obtained from various small veins of ferruginous quartz which have been traced there.

The entrance to these ancient mines has long since been closed, still, the mineral existing in the spoil banks prove that the auriferous quartz veins contain pyrites of iron and other elements.

The sandy deposits on the sides of the small rivers *Acaroque, Orgamello* and *Chorrillos* contain gold and the Indians still collect it from these as also from various other regions, but there is evidence to prove that in ancient times such gold washings were carried on upon an extensive scale and during

a considerable period of time. The processes, however, employed in those ancient times were of the rudest kind, and it is highly probable that such workings may be traced back to the Inca period.

In the neighbourhood of a place called *Incachuli* near to the rise of a small river, *Acaroque*, other ancient gold washings were carried on upon a large scale. The auriferous deposit at this place consists of red gravel and sand, and in more modern times the Indians have obtained from it nuggets of gold half an ounce in weight.

All the gorges at higher altitudes contain auriferous sand and debris in a greater or lesser degree, but these have been neglected.

In recent times, some persons proposed to form a company to exploit the gold washings of *Incachuli*, but the project does not appear to have been carried out. It is reported that in various other places, not clearly defined, that various auriferous deposits, and, also, mineral veins containing gold, have been traced but not exploited.

In the district of *Canchari*, various veins of mineral may be traced containing copper, silver, gold and lead; and, also, in the Cerro *Curato* and *Medano* veins of copper ore have been discovered as, also, in *Lari*.

At a place called *Turutiri*, ancient mine workings have been discovered, but these do not appear to have been reopened in modern times.

It is reported, upon good authority, that certain miners from Salta have obtained considerable benefit from the mines situated in the district of "*Oro del Carmen*"; but the nature of the mineral has not been described, however, we may infer from the name of the district that the veins of mineral contained gold.

Speaking in general terms, information is to hand that in

various other Departments in this province, important mines have been discovered and that excellent results have resulted.

Mines of Molinos. In the valley of *Amayeba* a considerable number of mines have been located: the veins ocurring in them consist for the most part of Galena and copper.

In various localities, such as *Lauracatao,* the veins of mineral discovered contain carbonates and sulpides of copper intermixed with native copper, some of the veins contain pyrites of iron and other mineral, yielding gold and silver.

In the Department of *Cafayate* a large number of mineral veins exist and some of these have been proved to a few metres in depth, and have yielded copper, gold and silver. They run in a north and south direction and have considerable thickness. It has been reported that one of the veins contains native copper and gold.

In one of the Quebradas, to the west in the district of *Punta de Diaz,* a large number of samples of Galena have been discovered assaying but little silver. However, they incited the curiosity of the miners who explored the higher regions, from which it was believed the samples had fallen. Such investigations were rewarded by the discovery of a considerable number of ancient mines believed to have been worked by the Indians and spaniards. These old mines were not, however, thoroughly examined, much less proved so as to ascertain their productive capacity.

In the mountains which separate *La Viña de Guachipas de San Carlos,* a vein of native copper containing gold has been exploited, but the vein does not seem to have been continuous and was considered by the native miners to have been lost.

In the Cerros of *Rosario de Lerma,* a large number of ancient mines are known to exist, the veins consisting of galena and pyrites, which have been worked to a considerable depth, and, for this reason, would seem to indicate the latter

period of spanish mining. The great depth attained in these mines is an exceptional case.

Not many years since, works were placed in one of these mines, but it does not appear that the results were satisfactory.

These mines are situated at places called *Golgota, Cabrillas* and *Cerro Negro,* the first name of which seems to be very significant and not over encouraging to those who may desire to re-open these old mines. The attemps to open one of them, as previously noted, nearly proved fatal for the reason that an abundance of gas and water was encountered. It is believed that Mr. John Pemberthy, previously referred to in the description of La Rioja, was the engineer of the mines at the time of this accident.

In the serranias of *Salta* and *Caldera,* and at a place called *Alejo,* near to Cerro Negro and in the *Pedrera,* mines of copper and galena also exist. Some of the veins contain carbonate and pyrites of copper, and also gold and silver: samples obtained from these gave high percentages.

In the Department of *Irua,* a large number of mineral veins have been discovered; but few of them proved.

In *Santa Victoria* exist also many mineral veins, but few of them have been explored.

We have already, mentioned that lavaderos of gold, i. e., gold washings existed in various directions, and were considered in ancient times to be very important, but what they may be capable of yielding under a good modern system of mining is a question for the future.

The mines of antimony, previously referred to, also contain silver, but whether these could be exploited with advantage cannot be stated.

Veins of galena are abundant in this province, and the mineral contained in them is presented in the usual form of sulphides and carbonates of lead, mixed with a certain percentage of silver.

The iron mineral existing in this province is generally found in the form of peroxide and pyrites which elements predominate near to the districts of *San Antonio de los Cobres, Acay, Irua, Santa Victoria,* and various other places.

This province also contains important deposits of Borate of Lime, and in the Poma various concessions for this mineral have been located. Other deposits of the same class of mineral exist in the Department of *Rosario de Lerma.* These mines are believed to possess great commercial value. The following is a general analysis of this class of mineral.

N.º 6

Water	33·79 °/₀
Sand	5·05
Oxide of iron . . .	0·39
Lime	12·81
Magnesia	0·32
Carbon.	7·38
Carbonic Acid. . . .	0·02
Sulphuric » . . .	0·26
Chlorine	0·46
Boric Acid	39·53
	100·00 °/₀

The elements represented in the following table N.º 7 were determined in the laboratory of the National Department of Mines and Geology.

N.º 7

Copper %	Silver %	Copper %	Silver %	Copper %	Silver %
0.64	0·280	—	0·016	6·66	0·76
6·67	0·054	43·90	0·013	0·999	0 274
1·40	0·182	6·50	—	—	1·144
0·64	0·104	48·50	0·120	0·999	1·892
0·80	0·250	10·00	—	4·272	0·354
	0·100	22·30	0·0032	50·830	0·136
—	0·009	0·368	0·054	0·70	—
—	0·176	0·680	0·820	33·70	—
—	0·030	2·106	0·356	30·90	—
—	0·124	—	0·154	34·50	—
—	1·858	0·158	0·068	40·60	—
11·10	0·658	24·640	1·366	1·40	—
10·43	0·556	—	0·208	—	—
9·77	0·580	23·430	—	—	—
0·888	1·022	2·370	0·017	—	—
—	0·718	3·986	0·208	—	—
10·43	0·069	3·056	0·088	—	—
29·30	0·072	20·202	—		—
12·43	0·678	16·539	1·209	—	—
2·75	—	14·985	0·700	—	—
1·95	0·003	5·106	0·222	—	—
7·65	—	—	0·230	—	—

The percentages of copper and silver contained in the above table N.º 7 were obtained from assays of a few of the common samples of mineral which were obtained from the mines of this province.

N.º 8

Copper %	Silver %	Ounces of silver per english ton	Copper %	Silver %	Ounces of silver per english ton
0·64	0·280	100·35	14·985	0·70	
6·67	0·054	19·35	5·106	0·222	250·88
1·40	0·182	65·22	—	0·23	79·56
0·64	0·104	37·27	6·66	0·76	82·43
8·80	0·250	89·60	0·999	0·274	272·33
—	0·100	35·84	—	1·144	98·19
—	0·009	3·37	0·999	1·892	410·00
—	0·176	63·07	—	—	678·08
—	0·030	10·75	4·272	0·354	—
—	0·124	44·44	—	—	126·87
—	1·858	665·90	—	—	—
11·10	0·658	235·83	50·83	0·136	—
10·43	0·556	199·27	—	—	48·74
9·77	0·580	207·87	0·70	—	—
—	—	—	33·70	—	—
				—	
0·888	1·022	366·27	—	—	—
—	0·718	257·32	30·90	—	—
10·43	0·069	24·73	—	—	—
29·30	0·072	25·80	—	—	—
—	—			—	—
12·43	0·678	242·98	34·50	—	—
2·75	—	—	40·60	—	—
—	—				
1·95	0·003	1·07	—	—	—
7·65	—	—	1·40	—	—
—	—	—	—		
	—				—
—	0·016	5·73	55·203	—	—
43·90	0·013	4·65	35·371	—	—
6·50	—	—	58·373	—	—
48·50	0·120	43·00	—	—	—
10·00	—	—	—	—	—
—	—	—	12·152	—	—
22·30	0·0032	1·79	7·595	—	—
0·368	0·054	19·35	11·935	—	—
0·68	0·82	29·38	20·211	—	—
2·106	0·356	127·59	—	—	—

N.° 9

Copper %	Silver %	Ounces of silver per english ton	Copper of %	Silver %	Ounces of silver per english ton
—	0·154	55·19	—	—	—
0·158	0·068	24·36	—	—	—
24·64	1·366	489·57	—	—	—
—	0·208	74·55	—	—	—
23·43	—	—			
2·37	0·017	6·10			

The above tables N.os 8 and 9, represents assays of a second series of samples of mineral obtained from the mines of this province, and may be taken to represent the general yield.

Extensive deposits of salt have been discovered as, also, deposites of lignite of excellent quality, an analysis of which will be given in the chapter dealing with the question of coal.

From all the most authentic information attainable we can only arrive at the conclusion that this province possesses great mineral wealth; but it is situated to the north of the Republic and is not so accessible as the mining provinces further south; for which reason it has not received so much attention. There is, nevertheles, every reason to believe that this province will have a prosperous mining future.

CHAPTER IX

Mines and Mining in the Province of Jujuy

This important province has a very irregular form, and its southern part is surrounded on all sides by the boundary line of the province of Salta; its northern portion is limited towards the south west by Chile: to the north by Bolivia and east by part of the province of Salta.

It extends over an area of 49·162 square kilometres, and is the smallest of all the mining provinces of this Republic. It is an exceedingly mountainous province, and some of these attain great elevation.

The capital of Jujuy has been estimated to have an altitude of 1300 metres above sea level; but the surrounding mountains rise towards the north, where, on the frontier line of Chile, Sapelari, attains an elevation of 5350 metres. Still further towards the north the mountain ranges of Esmecaco have an elevation of 5400 metres. The eastern mountain ranges are a little lower. That of Yavi has an altitude of 3986 metres.

This province is admirably situated prossessing similar geological conditions to that of Salta and the southern part

of Bolivia, consequently its mineral riches ought to be great.

The Cerros of Cobalonga, Santa Catalina, Cochinoco, Aguilar, Zenta, Calilegua, Barbara traverse the province in a northern and southern direction, from which there are various branches and ramifications with deep gorges, in all directions covering a large extent of land.

The Department of *Catalina* is situated in the northwestern portion of the province, its northern extremity abutting against a portion of Bolivia. Many auriferous quartz veins have been discovered in this district most of them running in a northern and southern direction; but there is no reliable evidence to hand referring to their productiveness. Another series of similar auriferous quartz veins exist in that noted place called *Rinconada,* and some of these are reported to have great thickness. There also exists another series of thin veins crossing the larger ones. History informs us that in a branch of one of these cross veins the ancient indians extracted *gold in bar,* but the works were not continued to a greater depth than from 15 to 20 metres.

It would seem that originaly this mine was called "*Rosario*", indicating that it was worked by the early Spaniards. The name of the mine was afterwards changed to that of "*Cruz del Sud*". The thickness of the auriferous veins are variable ranging from a few centimetres up to 2 metres. It is reported that in the mine "*Blanca*", several veins of mineral unite forming a vein of 15 metres in thickness. This vein of auriferous mineral may be traced for a considerable distance, and there is evidence that ancient works were made upon it at various points.

Some years since an adit was commenced from the side of the mountain at the level of the valley and driven through the rocks for a long distance, intersecting in its course several veins of mineral, the thickness of which ranged from 8 centi-

metres up to 1 metre. The mineral extracted from these auriferous veins was treated in a small Establishment, *Timon Cruz*, situated close to *La Rinconada;* but there is no data to hand referring to the results obtained.

On many occasions the writer examined various samples of auriferous quartz from the mines of this district and nearly all contained native gold. No doubt, selected samples would present a large proportion of gold, but this could not be accepted as a common assay produce such as would result from the treatment of many tons of auriferous quartz. It would appear that the auriferous quartz veins of this district have proved exceedingly rich at the surface, and, also, that at considerable depth the produce diminished. It has been reported that the auriferous quartz extracted from the adit, previously noted, yielded at the rate of from 1 to 1·5 ounces of gold per ton.

It is believed that a new syndicate has been formed in London with a capital of £ 6000, to prove the productive qualities of the auriferous quartz veins in this district and that, recently, works have been commenced for the object indicated. If success should be obtained no doubt a strong company will be formed to exploit the gold mines in this department upon a large scale.

At a distance of about 4 leagues to the south east of the Rinconada a mining district exists containing many veins of galena. One of the principal mines located there contains a vein of mineral 33 inches in thickness. These mines were also known to the ancient Indians who extracted the silver by primitive modes. In modern times ores have been extracted yielding as much as 207 ounces of silver per ton.

All the reports agree that a large number of auriferous quartz veins exist in various parts of this province, capable of

yielding sufficient gold to justify the expendieture of capital in their exploitation.

Considering that a practical proof is now being made in the *Rinconada* district, the success or failure of this syndicate will facilitate or retard the formation of other companies for the exploitation of the numerous auriferous veins to which we have referred. No doubt this is too much a rule in the mining commercial world, but it is not strict justice to the general mining interest, for the reason that some mining enterprises may fail from various causes and circumstances which, in all probability, would not in any way apply to other mines. In fact, it is a rule that every mine must stand or fall upon its own merits.

Generally the gold is distributed throughout the vein in minute grains. There are, however, exceptions and on one occasion the writer inspected a nugget of gold from these regions which weighed 92 grammes. Another nugget, probably the largest ever obtained in this country, was exhibited in Buenos Aires, some years since weighing 4 ½ kilos. A model of this nugget is still retained in the mineral museum of the National Offices of mines and geology.

The auriferous quartz vein called "*Cordobesa*" also runs in a northern and southern direction and some excavations have been made upon it to the depth of 25 metres. The mineral extracted yielded from 80 to 150 grammes of gold per ton.

The mine "*Porteña*" contains an auriferous quartz vein which has been exploited to the depth of 22 metres, with a reported yield of from 83 to 140 grammes of gold per ton.

The mine "*Riojana*" has also been exploited to a depth of 15 metres, and as yielded at the rate of from 90 to 160 grammes of gold per ton.

The mine "*Carmen Alta*" is said to contain an auriferous quartz vein of 15 metres in thickness, yielding from 20 to 25 grammes of gold per ton.

The mine "*Delfina*", situated in the *Rinconada*, is reported to contain an auriferous quartz vein yielding 28 grammes of gold per ton.

The mine "*Pampa Coya*", contains a vein of mineral running in an eastern and western direction, having a thickness of 6 metres and yielding at the rate of 30 grammes of gold per ton.

The mine "*Santo Domingo*" has been worked to a depth of 40 metres and the mineral extracted from it yielded 40 grammes of gold per ton.

Various other auriferous veins of minerat also exist in the same district.

The writer possesses no information referring to the quantity of mineral obtained from the veins referred to.

In the *Cerro of Cabalonga* exist a veln of auriferous quartz running in a northern and southern direction, and at a depth of 20 metres the yield was 35 grammes of gold per ton.

Various other auriferous quartz veins exist in this district, some of which have been proved to a depth of 10 metres with a variable yield of gold per ton.

In various branches of the lower mountains in this province many ancient mines have been discovered, some of which were worked for copper, gold and silver. In modern times, some attention has been directed to these mines with a view to their exploitation, but there is no evidence to show that formal companies with sufficient capital have engaged in their development. The fact that the ancient Indians and Spaniards worked these mines to advantage ought to be a sufficient incentive to others to attempt to exploit them.

Various engineers and geologists have visited the mines in this province on the part of Companies, or intended companies, but no proportionate permanent benefit has accrued to the province or the country at large from such investigations.

However, the provincial government should not hesitate longer in procuring a thorough official inspection of this province with a view of determining, as far as may be possible, the mineral resources and probable beneficial exploitation of the mines in the future.

Of the various concessions of mines obtained from time to time in this province may be noted a group of 17 pertenencias, or concessions of mines, some of which are named "*La Cata*", "*Nuestra Señora del Rosario*", "*La Andrea*", "*La Sofia*", "*Rivadavia*", "*Jujeña*, "*Pombal*", "*Maria*", "*Elvira*", "*La Elena*" and "*La Fortuna*", the last of which embraces 7 pertenencias. These mines are situated at a distance of 45 kilometres to the north of the town of Jujuy. The region in which the mines exist is difficult of access.

The mine *Jujeña* forms the centre of the group, and the principal vein of mineral in it runs in an eastern and western direction inclining towards the south. It is a well formed vein. At one time these mines belonged to a native Company, but the workings carried on upon the veins were not extensive, in fact, the excavations made were confined, more or less, to the surface, only sufficient to prove their quality and richness. Their thickness is variable, some being estimated up to 4 metres and the mineral extracted from them consisted of galena mixed with grey copper, iron pyrites and quartz and sometimes blende.

The yield from the mineral has been reported to be at the rate of from 300 to 1600, and up to 2600 grammes of silver per ton. There is no data to hand referring to the yield of copper, so that it may be inferred that it is low in percentage.

This group of mines was examined in 1898 for the object of forming a Company for their exploitation and it was proposed to erect *water jacket furnaces* for the reduction of the mineral. It appears that fundents, such as carbonate of lime and oxide

of iron, were abundant in the neighbourhood so that the reduction of the mineral would not have presented any difficulty. It was intended to run down the ores to the form of lead bars and to extract the silver by the ordinary process of cupelation, and for the treatment of the copper, electricity would have been employed and the water-falls utilised as a motive power. The estimated capital required amounted to £ 16.000, but the same engineer afterwards considered that if the exploitation were to be carried on upon a large scale £ 40.000 would be necessary.

No account can be given in this work of the assessed cost of working and benefit to be derived from the capital invested because the statements are not clear nor the results arrived at certain.

It was believed that the exploitation of this group of mines would prove a source of great ríches to the Company engaged in it, as also benefit to the province, and further the conclusion was arrived at that it was certain that the provincial and national governments would assist such a Company by all possible means. However, if the national government were to be urged to assist every projected Company for the exploitation of the mines, all the national resources would not be sufficient for that purpose.

Previous to 1893, Messrs Torre Brothers, of Buenos Aires, formed a Company called "*La Aurifera Jujeña*", to exploit the mines "*Buena Esperanza*" and "*Buena Vista*", situated at Aljadrez: the auriferous sand deposits existing at a place called La Puerta de la Quebrada de Colpayo; the auriferous deposits, gold washings, in the locality termed Campo del Aventadero: the auriferous deposits at the Campo Toreo and also some other gold mines.

It was not proved by any public returns that the writer has inspected what yield of gold could be obtained, or was

obtained from the mines under consideration and, consequently, there is nothing to justify an assessment of their commercial value, in fact from the circumstances it may be inferred that this company made no formal or extensive workings in the mines, for, we find that, 1893, the Company made a petition to the provincial government for an extension of time for a period of two years. It would also appear that the mines in question are situated at a distance of about 370 kilometres in a north west direction from Jujuy, in the district before referred to i. e., Aljedrez.

Some of the engineers who have visited this district say that the gold is distributed throughout the whole of this zone, and further that, if only one fourth part of the auriferous deposits were to be taken, it would amount to 60,000,000 cubic metres in favourable conditions for exploitation. It is also calculated that the thickness of these auriferous deposits varies from 15 to 30 metres and, also, that the necessary sum required to exploit them would amount to £ 40,000. The cost of exploitation has been estimated at 11 cents, gold, but the absolute yield of gold per cubic metre is not given. It has, also, been stated that if the gold washings only yielded 0·180 grains of gold per cubic metre, the exploitation would produce great benefit; but as this is only a probability, the yield may be much less rendering a profit improbable, but it is also possible that the yield may be greater than the estimate.

The yield of gold from such immense tracts of auriferous sand and conglomerate deposits, to form a basis upon which to expend large capital sums could hardly be guaranteed supposing that, for a proof only 50 or 100 cubic metres, had been treated from each section containing 1,000,000 square metres; but we have it stated that the trial excavations made in the auriferous deposits were at a great distance, one from the other, so that whether the intermediate areas were richer

or poorer has to be proved. We cannot learn that the exploitation proprosed was ever carried out.

The small population at *La Rinconada* is not altogether of modern date, and the locality has been estimated to have an altitude of 3920 metres.

The *Rinconada*, has become historic throughout the Republic on account of its rich auriferous deposits, which have been reported to extend along the bottom of the valley, *quebrada*, for a distance of 4 kilometres. Those who have inspected this locality, one of the principal of which was the late Mr. Huniken, of Chilecito, stated that the land near the small village referred to has been removed, and that the remains of ancient indian workings may still be traced.

Some few years since it was reported that one of the lakes of this province contained gold, and it was further urged as evidence that the periodical inundations caused the lake to overflow carrying with it a few grains of gold which were deposited at lower levels. Taking advantage of this story, two adventurers came to Buenos Aires, procured an interview with a very high official for the object of representing that the lake contained an immense amount of gold, sufficient, indeed, to pay off the national debt, and give fortunes to all concerned. This story had the desired effect, and a sum of money was advanced to drain the lake. However, no evidence has come to hand that it ever took place.

Like all the other mining provinces of the Republic, that of Jujuy, has been visited by various Engineers, for the purpose of discovering mines for company purposes, but the results have not yielded the benefit which was expected to accrue from such investigations. Many pamphlets have been published from time to time upon this province, the principal of which was that of the late Doctor Brackenbusch, upon the Petroleum district of the Laguna de la Brea. He arrived at the

conclusion that a large quantity of petroleum existed in that district, and such an opinion, expressed by a man of science drew public attention and finally, in order to develope the petroleum districts of Mendoza and Jujuy, a foreign geologist was appointed who conducted perforations in the provinces named. In the two places selected in the province of Jujuy perforations were made to considerable depth, but no beneficial results were obtained and consequently the works were abandoned. This resolution adopted by the company must have been severely felt by the geologist, who had previously formed such a favorable opinion upon the productive qualities of these petroleum camps.

It has been stated that the works were abandoned for the want of sufficient capital.

It is certain that an oily substance is apparent upon the waters of the Laguna de la Brea, which has been considered by geologists to issue from the rocks of the neigbourhood, and this led to the formation of the opinion that large deposits of petroleum exist in this district.

The first Mining Engineer of the National Government offices of Mines and Geology, Mr. Carlos A. Lynes Hoskold, was commissioned by the then Minister of Agriculture, Commerce and Industries, Doctor Garcia Merou, to visit the districts under consideration with a view of determining the extent, value and application of a deposit of Asphalt which was reported to exist at a place called Garapatal situated at a short distance from the important and extensive sugar manufactory belonging to Messrs. Leach and C.° The report of the Engineer referred to, which is intended to be included in this work, shows that the Asphalt deposit was of a limited extent and did not possess the value attributed to it.

An American Engineer, expert in Asphalt deposits and connected with the Trinidad Company also visited this repor-

ted Asphalt deposit at the place referred to, and was in accord with the conclusions arrived at by the National Government Mining Engineer, previously alluded to.

The report of the latter, contains a very important discussion upon the mineral resources of this province, and among the ideas emitted, is that which proves the existence of petroleum, and that the former explorations which had been carried on by the company, previously mentioned, were not sufficient to prove the existence or non-existence of deposits of petroleum in payable quantities. It was also suggested in the same report that in order to solve this important question other perforations should be made further to the north.

All the explorations which have been carried on in this province prove to a demonstration, that in various departments numerous veins of copper ore exist, some of which have been tested and others remain in a virgin condition; but the writer is convinced that if they were to be practically examined it would be found that they offer every condition for a favourable exploitation and that if sufficient capital were to be raised and applied under adequate administration good results would be obtained.

CHAPTER X

Mines and Mining in the Province of Mendoza

This province is situated to the south of that of *San Juan*, to the west of that of *San Luis*, to the south it is bounded by the northern limits of the National Territory of Neuquen, and to the west by a portion of the eastern limits of the Chilian Republic. Its area, according to official estimates, is 146/378 square kilometres.

It is celebrated for its important mineral springs, one of the most notable of which is that near to the renowned *Puente del Inca*, (Bridge of the Incas) over which the road passes which, leads through the valley of *Uspallata*, to Chilie.

The writer has already expressed himself upon the gold mines, and the mining operations carried on in this province by the ancient Indians and Spaniards, in the 1st. Chapter.

Some years since the government of this province initiated an exposition in the town of Mendoza, capital of the province, under the title of *"Inter-provincial"*, and on that occasion much energy and ingenuity was displayed. A valuable collection of minerals was obtained from the mines then under exploitation, forming one of the most interesting and

important sections of provincial produce that figured in the exhibition.

As is the case in all the andine provinces, the mountains of this province extend over a large area, and in the various districts situated in such elevated regions the mines exist.

The principal classes of economic commercial minerals consist of copper, gold, silver, lead, coal, marble, petroleum, building material, etc.

The mines of this province were exploited by the Spaniards, and since that epoch the concessions granted by the provincial governments have received, at various epochs, considerable attention. Nevertheless, the mines have not hitherto been worked in a continuous manner. Such intervals have arisen from various causes, but after the abandonment of some of the mines, others with more spirit, perseverance and, possibly capital, have again obtained the rights of concession of the same mines with a view to their exploitation.

In the chapter which we have set apart for the discussion of general subjects, we shall have occasion to enter more fully in detail upon this subject.

When the National Government ordered a general inspection of the mines of this Republic, some years since, the writer commissioned some of the Engineers of the then National Department of Mines and Geology, to examine and report upon the condition of the mines in this province, and as there has been, since that epoch, but little attention paid to the mining industry, from a formal point of wiew, some of the information then obtained will be incorporated in this chapter.

The mountains to the east of great *Cordillera de los Andes* are called *precordilleras*, and the highest point in these is that called *Aconcagua*, situated about in latitude 32° 40' south, and longitude 69° 57' 30" west of Greenvich, the height of which has been calculated to be 24,000 feet above sea level.

Mr. Fitz Gerald, formed an expedition some few years since with the object of making an ascension, but he was unable to effect his proposition attaining only an elevation of 23,000 feet.

It was however reported that his swiss guide reached the sumit; but we do not, however, hear that any mineral veins were discovered by them.

The Mineral Districts and Nature of the Minerals found in Them

1. *La Cortaderita.* . . Mines of gold and silver.
2. *Uspallata* . . . . " " silver.
3. *La Pintada* . . . . " " silver and lead.
4. *North*. . . . . " " gold.
5. *South* . . . . . " " gold.
6. *Las Choicas.* . . . " " copper, gold and silver.

In the first named district the mines "*Carmen*", "*Verde*", "*Brillante*", *Esperanza*" and others are located.

The mineral veins in these mines consist of *Galena;* but some of them have yielded gold and silver.

The mine "*Negrita*", contains a vein 1·20 metres in thickness, but no works of great interest have been placed upon it.

The greatest depth reached was 18 metres.

A large sample obtained from this mine gave the following assay:

Silver	11·650	kilos per ton
Gold.	0·148	" " "
Lead.	52·000	" " "

The mine "*Esperanza*", has been exploited and contains 5 distinct veins, that is to say, the "*Esperanza*", the "*Panchita*",

"*Veta de Agua*", the "*Ernestina*" and the "*Manuela*", all of which run in an eastern and western direction.

The principal mineral vein appears to be the *Esperanza*, which was cut at the end of a gallery driven in from the side of the mountains for a distance of 32 metres.

It has been reported that a considerable amount of rich mineral has been extracted from it, the average yield of which is said to have amounted to 20 kilos of silver per ton. Some of the parcels of ore extracted assayed 32 kilos of silver per ton. The mineral was sent to Europe. Other samples yielded:

10·120 kilos of silver per ton and
290 grammes of gold per ton.

It appears that in depth the silver decreased and the gold increased.

There are various other mineral veins of this class in this district, but there is no data to hand affording evidence as to their productive capacity.

One of the persons of the mining office of this province, stated that no formal exploitation, according to a good modern system, has as yet been organised and applied to these mines, and so free the mines from the destrutive element, of adventurous miners who run over the mountains, making small pits, or excavations, with a hope of discovering and extracting some rich superficial deposits of mineral, filling them in afterwards with debris and so rendering the veins more difficult to be dealt with when a formal explotation is undertaken.

This is undoubtedly true, but it demonstrates the laxity of the provincial mining authorities in not enforcing the exact compliance with the dispositions of the National Code of mines.

In the mining district of the *Cortaderita*, some of the mines already described, appear to offer every condition of success supposing that their exploration were carried on with sufficient capital, and under a good and economic system of management.

The Mining District of Paramillo de Uspallata

This mining district is situated in the southern part of the *precordillera of* the *Tontal* range of Mountains in the province of San Juan, and its altitude has been calculated at about 2,862 metres above sea level, being located by some in latitude 32° 28' 47" south, and 69° 7' 31" west of Greenwich.

The formation has been doubtfully classified as apertaining to the *Rhætic formation,* but the characteristic fossil of that formation, the *Avicula Contorta,* has not been discovered.

In this district several veins of galena have been worked, and various companies have carried on mining operations in this region, but it is not known whether a sufficient benefit was derived upon the capital invested. If it could be proved in the negative, it is doubtful whether it arose from inadequate management, or the poorness of the ores The writer is inclined to believe that the fault may not be traced to the inferior quality of the ores.

The mineral veins are composed of carbonate of iron in which the galena is found. In some of the veins other elements enter such as blende, quartz, etc., exist.

Mining District of La Pintada, or Piedra de Afilar

This district is situated at a distance of about 36 kilometres to the west of the town of San Rafael (Department of 25 de Mayo).

The mine "*Celia*", ocupies nearly the centre of this district which has been calculated to be in latitude 34° 30′ 35″ south, and 68° 44′ 22″ longitude west of Greenwich.

It has an altitude above sea level of 1088 metres, and extends over an area of 5 square leagues.

The mineral existing in these veins consists of galena, copper, iron pyrites, etc.

Various mines have been conceded in this district, and about 15 of these have been exploited at various times, but as the veins of mineral have but slight variation it is not necessary to describe the whole of them.

The mine "*Infierno*"; after this mine had been abandoned, it was again granted in 1896. The outcroppings of the vein of mineral may be traced for a distance of 500 metres in a direction of south 26° west, inclining at an angle of 5.° 30′ towards the east. The thickness of the vein averages from 20 to 50 centimetres and is composed of argentiferous lead mixed with pyrites of copper carrying silver, and gold.

The workings in the mine have been continued to a depth of 35 metres, and the ore extracted was formerly taken to Chile. The yield was at the rate of.

Silver	1·250	kilos per ton.
Gold	0.045	

with a considerable quantity of copper and lead.

An adit of 43 metres in length has been driven from the side of the mountain to interseet the mineral vein. Various other parallel veins of the same nature exist in this mine.

The mine *Celia*. This mine has been worked more than any other in this district. The vein of mineral runs in a direction of north 12° east, and has a thickness of 30 centimetres. It is composed of argentiferous lead, iron pyrites etc., and at

the surface it was comparatively poor, but became richer in depth.

The mine was abandoned from 1877 to 1892, when it was again obtained in concession. A cross vein was opened up, and yielded a considerable amount of silver.

The mine "*Transito*". In this mine the principal vein of mineral runs in the direction of north 43° east, and has a thickness of 96 centimetres, composed of argentiferous lead, with iron pyrites, which have yielded at the rate of 2·630 kilos of silver per ton with a large quantity of lead.

A gallery has been driven into the mine for the object of draining the water and extraction of the ore.

It has been considered that this vein of mineral is the most important in the whole district.

Deposits of Coal

The districts containing indications of carboniferous beds, have been visited by Engineers and Geologists, more than any of the other mining zones in this province, and, considering that all the reports emanating from the so called studies referring to the regions, were of the same character, indefinite and impractical, the writer commissioned one of the Engineers of the then National Department of Mines and Geology, to visit, examine and report upon and determine the commercial value of the coal field. The report presented by the Engineer was published in 1897.

The Engineer, in question, Don Florencio Martinez de Hoz, stated that this coal-field is situated at a distance of 300 kilometres in a south western direction from the capital, Mendoza, and at a distance of 150 kilometres from the village of San Rafael, in the region of the precordillera.

Three concessions, or mines, denominated "*Mitre*", "*Eloisa*" and "*Roca*" had been conceded.

The altitude of the first named was estimated at 2000 metres above sea level, and the bed of coal contained in it has a direction of east and west inclining towards the north, but it seems that the direction changes at within a short distance.

The concessions or mines "*Eloisa*" and "*Roca*", are situated at a distance of about from 7 to 8 kilometres in a northern direction from the "*Mitre*", and at an altitude of 3,200 metres above sea level. It is stated that the beds of coal is from 80 to 100 centimetres in thickness at a depth of 11 metres.

Others, however, have estimated the thickness at from 80 centrimetres to 4 metres. Between these estimates there is a great difference, and can only be reconciled upon the grounds that some persons have mistaken the direction in which measurements should be taken in order to determine the proper thickness.

The writer has frequently found it necessary to explain the simple problem that the thickness of a vein of mineral should always be taken in a direction at right angles with the dip of the vein, still, after all this, it has been affirmed to the contrary, and consequently there are those who have taken an opening upon the direction of the outeroppings to be the thickness of a bed of coal and thus it has been stated that it has 4 or some other number of metres in thickness.

The coal measures in this locality have been much disturbed changing the direction of the outcroppings, within a short distance, but the quality of the coal is excellent, although very friable.

The disturbed strata is seen to greater advantage near to the mine "*Transito*", 2500 metres above sea level.

This concession contains 4 seams of coal of about 40 centimetres in thickness each.

There is, also, a difference of opinion as to the geological age of this coal formation. The Engineer, above referred to, believes that the rocks belong to the inferior part of the *Lias*. However, the opinion of Doctor Rodolfo Zuber, is that this coal field may not be newer than the *Permian*, but in the absence of fossils characteristic of this formation, which do not appear to have been discovered, we must infer that the correct age of the rocks in which the coal beds exist has not yet been accurately determined.

This coal has been analyzed by several persons, but the most important is that made by Doctor Kyle chief of the laboratory of the government Mint.

A preliminary trial gave the following results:

Fixed carbon	47·81 %
Gases and volatile matter . .	49·51 "
Water.	2·05 "
Ash.	0·63 "
	100·00

After eliminating the water and ash, an analysis gave the following yield:

Hydrogen	8·63 %
Oxygen	25·12 "
Carbon	60·59 "
Nitrogen	1·43 "
Sulphur	4·23 "
	100·00

The specific gravity of the coal was found to be 1·173 and its calorific power 5·485.

After having made several chemical and other scientific studies of the ash, derived from the coal, Doctor Kyle, made the

interesting discovery that it contained *vanadic acid* in quantities of commercial value. This was the first occasion on which this valuable element was known to exist in coal. No doubt various celebrated chemists have assayed the ash of coals of other countries on many occasions, and if *vanadic acid* had been detected, all the scientific journals and papers would have published the facts, but no such notices have been given, consequently the honour of this important discovery must be accorded to Doctor Kyle.

A complete analysis made by him is given below:

Soluble in Nitric acid	Pentoxide of vanadium ($V^2 O^5$). . .	38·22
	Phosphoric pentoxide	0·71
	Sulphuric anhidride	12·06
	Calcium oxide.	8·44
	Ferric oxide.	4·98
	Aluminium oxtde.	3·32
	Potassium oxide	1·72
	Silicic anhydride	13·70
Insoluble in Nitric acid	Ferric oxide.	9·42
	Aluminium oxide.	5·26
	Magnesium oxide	0·83
	Traces not determined of chlorine manganese, magnesia and loss. .	1·33
		100·00

The weight of the ash in an English ton of this coal at the rate of 0 63 °/₀, would amount to 14·11 lbs., and as the vanadic acid is at the rate of 38·22 °/₀, the weight of acid would amount to 5·39 lbs., which at 17ˢ /5ᵈ per pound, the average value price of the acid, likely to be obtained in the market the total value of the acid contained in a ton of coal would amount to £ 4 14ˢ 6ᵈ ½.

Doctor Kyle found that from a treatment of the Vanadic

Acid in an ammonical extract, 80 °/₀ of the quantity existed in the form of a free anhidride, and that 20 °/₀ existed in combination with oxide of iron and alumina.

The writer exhibited samples of this coal at the Chicago Exhibition in 1893, for which a prize was awarded; he also brought this scientific discovery before the notice of the Jury of Awards, and the highest award was accorded to Doctor Kyle, for his interesting and important discovery.

Much curious speculative inquiry may be entered into referring to the mode in which the Vanadic Acid found its way into the coal, but no acceptable theory can be advanced, unless the acid is proved to exist in all parts of the coal at great depths. If it should so exist, then it must have been derived from some independent source and deposited at the time when the coal bed was in formation; but if it should not so exist, then it would prove that it was infiltrated into the coal seam near the surface after the carboniferous beds were formed.

These coal beds have not been sufficiently worked to enable one to form a correct opinion as to the area over which the coal basin extends. There is however, no reason to fear that the importance of this coal field will not be appreciated when a branch railway is constructed connecting it with the main trunk line.

Northern Gold Mining District

Department of Las Heras

This district is situated at a distance of about 80 kilometres in a northern direction from the town of Mendoza, and has an altitude of about 2940 metres, above sea level.

There are but few mines in this district, the best known being "*Al fin hallada*", "*Salvadora*" and "*Deseada*", and

there appears to be four mineral veins upon which works have been placed.

Some years since a small company was formed in Mendoza to exploit these mines, and a stamp mill was erected to treat the mineral extracted, but so badly was it put up that when the machine was set in motion many of its parts immediately gave way and it had to be abandoned. Here again we trace the want of technical skill in conducting such operations, but it is only a repetition of what has taken place all over the mining districts of the Republic.

Southern Gold Mining District

Department of Las Heras

This district is situated a distance of about 15 leagues in a northern direction from Mendoza, and has an altitude of 3025 metres above sea level.

The principal mines, which have attracted attention from a remote period, are called "*Boques*", "*Mascareña*", "*Trinidad*", etc.

The veins of mineral contain oxide and pyrites of iron, and auriferous copper in a ferruginous quartz base.

The chief of the office of mines in Mendoza has reported upon these veins as follows: It has not been possible to obtain mineral samples from these mines necessary to control what has been said about their richness. However, the character of the veins themselves, goes to prove that there exists a great variation in the percentage of the metal derived.

The late Mr. Castells, of Buenos Aires, endeavoured to secure these mines some few years since, with a view of forming a syndicate, to exploit them, but although he expended a considerable sum in endeavouring to negotiate, still he found it necessary to abandon the project.

There are various reports current referring to the cause of the failure; but it would not be good policy to enter into any such details. Nevertheless, we have cited quite sufficient, and is possible that these mines may again to come to the front.

Whether they are good, bad or indifferent the writer has no evidence to show.

Copper Mineral District of the Choicas

Department of the 25th. Mayo

The mineral district of *Las Choicas,* or *Cajon de la Fortuna,* was discovered in 1875, the fortunate discoverers being Messrs. Labarca and Bobadilla, and they believed, as others do to day, that these mines are the richest hitherto discovered in the Cordillera de los Andes.

Since that period, various other copper lodes of less value have been found in the same district, so that many persons in this province are of opinion that this a very important mining district.

It extends over an area of about 2 square leagues, and is situated at an altitude of about 3,270 metres above sea level.

The veins of copper ore existing in these mines run in the direction of north and south, and, at the surface, the principal vein, *Choicas,* measured no less than 32 metres, but at a certain depth it diminished to from 8 to 10 metres in thickness.

The outcroppings of this vein can be traced for a distance of 600 metres. The ore consists of *Chalcopyrite* and other classes of copper, such as, for example, *Bornite,* the body of the vein consisting of ferruginous matter and quartz.

Large parcels of mineral extracted from the vein *Choicas* assayed.

Copper	480·000	kilos per ton.
Silver	2·300	
Gold	0·021	

But the average produce of the mine may be taken as follows:

Copper	300·000	kilos per ton.
Silver	1·600	
Gold	0·016	

It has been estimated that for an average depth along that part of the vein visible at the surface, the mine contains 648,000 tons of ore. This estimate does not, however, take into account the immense quantity of copper ore which, in all probability exist below this level.

RARE MINERALS.

About 1856 or 1857, a vein of mineral was discovered in the Cerro de Cacheuta, containing ore which, at that time, was considered, in this country, to be curious and rare. The writer could not obtain samples of it, but the following analysis represents its contents.

N.°	ELEMENTS	1	2	3	4	5
		%	%	%	%	%
1	Silver	21·00	20·85	9·80	3·75	—
2	Copper.	1·80	12·91	10·20	13·80	—
3	Selenium	30·00	22·40	30·20	—	23·60
4	Cobalt	0·70	1·26	2·80	1·95	—
5	Iron	2·20	3·10	1·20	3·35	0·80
6	Lead.	43·50	6·80	37·10	21·25	57·80
7	Carbonate of Lead .	—	—	—	15·20	10·90
8	Ferruginous matter .	—	—	6·50	—	3·50

The vein of mineral was very thin, and after it was traced to a depth of from 30 to 40 feet, it disappeared completely and, according to report, not a trace of it could be found in any other place. For these reasons one of two things occurred, i. e., it was an isolated deposit, or a displacement by a fault existed. However such a small quantity of mineral extracted only served for experiments, public museums, and the cabinets of the curious.

Of the various samples of copper and silver minerals extracted from the mines of this province, some were assayed in the laboratory of the National Department of Mines and Geology, the results obtained being exhibited in the following table.

Copper %	Silver %	Copper %	Silver %	Copper %	Silver %	Copper %	Silver %
3·00	0·04	10·00	0·05	12·90	1·38	10·60	0·48
10·40	1·76	12·70	1·26	9·00	6·33	10·00	0·29
6·40	2·10	10·09	0·34	13·25	2·58	6·30	5·22
13·70	1·84	10·45	0·13	13·50	1·69	14·50	0·08
10·75	1·02	14·45	4·07	10·30	0·23	30·00	0·03
5·75	0·05	12·40	1·20	25·40	0·82	35·60	0·10
16·70	0·21	18·20	0·74	40·10	0·09	20·10	0·07
24·30	0·45	34·10	0·02	36·40	0·01	36·40	0·02
12·13	0·10	22·80	0·10	41·20	0·02	13·14	0·18
14·16	0·42	34·60	0·84	37·10	0·11	10·12	0·14
38·40	0·14	20·50	0·46	29·30	0·04	17·80	0·05
19·90	0·06	18·10	0·14	24·10	—	14·18	—
10·40	—	11·40	—	19·10	—	12·60	1·42
13·70	0·01	16·80	1·03	10·11	0·45	9·50	0·23

PETROLEUM

In the year 1880, a company was formed in Buenos Aires with a capital of 120.000 dollars, with the object of purchasing

perforating machinery to prove the existence of petroleum at a place called *Cacheuta*, in this province.

Old fashioned French percussion machinery was employed and consequently progress was slow and tedious.

Petroleum was found in the first well at a depth of 200 metres, but not in sufficient force to reach the surface.

The second well reached a depth of 77 metres, but it does not appear that the principal deposit of petroleum believed to exist was reached. Consequently, a third perforation was made to a depth of 103 metres, from which 35 barrels of oil per day was obtained for a short period.

The company laid down a line of pipes 4 ½ inches in diameter from the wells for a distance of 35 kilometres. Afterwards the capital of the company was augmented to 240,000 dollars, and the works proceeded at the mines, including the construction of an iron deposit at the termination of the line of pipes.

It does not appear that this company realised sufficient benefit upon the capital invested in the petroleum wells.

From a report made by the chief of the Register of properties etc., of Mendoza, dated June 19th 1903, the following list of mines represented those under exploitation.

DISTRICTS	N.° of mines
Paramillo de Uspallata.	12
La Cortadera.	5
Las Higueras.	2
Challo	1
Las Cuevas	3
San Rafael.	8
La Pintada.	1
El Nevado.	1
Total number of mines. .	36

These consisted of silver, copper and lignite.

CHAPTER XI

Mines and Mining in the Province of San Juan

This province is situated between those of Mendoza, San Luis and La Rioja, and its boundary towards the west is the eastern limits of Chile. It extends over an area of 87,345 square leagues.

It has already been indicated in the first chapter that the Indians and Spaniards worked the mines in this part of the country for a considerable period, and it has been estimated that they exploited about 40 mines of gold and silver, and that a large quantity of gold was obtained. Many of these ancient mines have been abandoned and nearly forgotten.

The history of these mines, from the time of the Spaniards up to the present, exhibits that the mines have not been exploited continuously, but subject to decadence caused by various circumstances such as, for example, inadequate capital, bad management and, above all, undue speculation tending to ruin legitimate mining.

In this province a great number of galena or argentiferous lead mines exist, but since the fall in the price of silver these have had to be abandoned and the same remark apply to the numerous silver mines, proper, which also abound.

However, a great redeeming mining feature is that the province is very rich in copper mines, but although the price of copper has been very high for a considerable time, and in all probabilities will continue, still, the copper mining industry has not advanced with the progress of the times, arising from the fact that little attention has been directed to this branch of mining and, consequently, large capital sums have not been introduced in order to create a legitimate, lasting and beneficial copper mining industry.

In this, as in all the other mining provinces exist a large number of veins carrying low grade copper ores, which could be utilized to great advantage, supposing that comparatively cheap modern systems of mechanical concentration and chemical processes, so well known and practiced in other countries were to be introduced and applied in this Republic.

A description of the various processes adopted for the extraction of copper from its ores will be discussed in detail in the Chapter which we intend to devote to metallurgy as it is carried on in this country.

Although a large number of auriferous quartz veins exist in this province, but few are under exploitation.

One of these existing in the district of *Castaño Nuevo* with great success by the French Engineer M. Sabattier, and considerable benefit obtained from it.

The vein of mineral has a thickness of 80 centimetres and the mineral is now being treated by the cyanide process.

The other quartz veins run up to one metre in thickness, but the want of capital and application of modern systems of extracting the gold, these mines have, also, been abandoned.

No doubt the larger lodes of lead ore could be utilized if proper establishments were to be erected for the economic reduction of the mineral and its conversion, into metal tubes, etc., for use in this country as at present nearly the totality

of this metal consumed in the Republic is introduced from foreign parts.

Various other classes of minerals which may possess commercial value exist in great abundance, especially sulphur, also, iron, asbestos, etc., but these mines have not been exploited to any extent.

In all parts of the province building materials abound and the large deposits of lime stone is at present exploited for its convertion into lime.

An official communication was made to the government of the province, indicating that the National government had arranged to represent the natural and manufactured products of the country at the San Louis Exhibition, and although the writer was authorized to solicit from all the provincial governments data referring to the mines, mining and metallurgy in each province that of San Juan, up to the present i. e., 10 April (1904) has given no information, consequently the writer considers that it would be imprudent to enter into a detailed description of all the concessions of mines existing in the various districts of the province.

Sometime since, however, it contained no fewer than 105 mining districts distributed over 13 Departments, and the number of mines, of various classes, is shown in the following list.

CLASS OF MINERAL	N.° of Mines
Gold	150
Gold and silver	71
Gold, silver and copper	7
Copper and silver	26
Copper	23
Sulphur	2
Coal	22
Roman earth	1
Alum	1
Silver	838
Total	1·141

The information given was obtained as stated from the provincial records and relates to the state of mining as it existed some years since, but for the reason previously assigned, similar data referring to the number of mining concessions existing at present cannot be given.

The following table represents some of the assays of mineral obtained from the mines of this province.

Gold %	Silver %	Copper %	Ounces of gold per ton
—	0·0332	0·03	—
—	0·0560	—	—
—	0·3160	—	—
—	0·2760	23·17	—
—	0·4360	—	—
—	0·3760	—	—
—	—	14·00	—
—	—	27·27	—
—	—	25·90	—
—	2·2460	—	—
—	1·2380	—	—
—	0·5000	15·90	—
—	3·7940	4·99	—
—	1·5000	15·90	—
—	0·4450	4·99	—
—	0·9320	3·20	—
—	0·8640	1·60	—
—	8·6400	—	—
—	6·2160	—	—
—	3·2600	10·00	—
—	0·0200	57·27	—
—	0·7040	8·80	—
0·0038	0·0180	37·367	1·35
0·0040	—	—	1·43
0·0145	0·0515	23·157	5·19
0·0053	0·0435	—	1·971
0·0460	0·3460	—	16·480
—	0·0740	30·663	—
0·0016	0·0560	7·110	0·573
—	0·0460	30·883	—
0·0070	0·0350	17·998	2·500
0·0050	0·0330	17·880	1·935
0·0036	0·0440	—	1·290
—	0·0500	16·887	—

It will be observed that some of these samples of mineral show by assay such a percentage yield as would justify the introduction of a formal exploitation of the mines.

The following table of percentages also confirms the above remarks, and proves that the mines from which they were obtained are sufficiently good supposing always that the general conditions and circumstances are favourable, as also, that an abundance of mineral can be extracted:

Copper per cent	Silver per cent	Gold per cent	Copper per cent	Silver per cent	Gold per cent
5·830	0·0420	0·0230	28·070	0·0054	0·0042
8·330	0·0050	0·0056	21·900	0·0510	0·0025
13·220	0·0230	0·0035	52·070	—	0·0140
22·800	0·0300	0·0140	10·410	0·0620	0·0067
12·290	0·0500	0·0067	16·450	0·0650	0·0082
5·110	0·0420	0·0500	5·100	0·1180	0·0045
22·910	0·1160	0·0250	16·660	0·0590	0·0123
5·830	0·1210	—	12·490	1·1490	0·0062
9·940	0·0720	0·0542	15·200	0·5240	0·0014
4·990	0·4450	—	30·100	0·0820	0·0025
30·890	0·0460	0·0040	17·600	0·0352	0·0054
10·426	0·1450	0·0116	18·200	0·0564	0·0124

CHAPTER XII

Mines and Mining in the Province of San Luis

This mining province is situated between those of San Juan and Mendoza, Cordoba, La Rioja and the National Territory of the Pampa Central, and extends over an area of 73,922 square kilometres.

This province appears to be divided into 8 principal districts, or Departments as they are termed, i. e., 1st. Capital; 2d., *Saladillo;* 3d., *San Jose del Morro;* 4th., *Renca;* 5th., *San Martin* or *Santa Barbara;* 6th., *Santa Rosa* or *Piedra Blanca;* 7th., *San Francisco,* and the 8th., *Nogoti.* The Capital of the second Department is called *Saladillo,* and the sub-divided departments consists of *Saladillo*, *Rosario*, *Paso del Rey*, *Carolina*, *Viraorca* and *Traga.*

The principal mountain in this province is the historical *Tomalasta,* which attains in the Cerro Carolina an altitude of 2,117 metres above sea level. The *Capilla* and small village situated at the foot of Tomalasta has an altitude of 720 metres above sea level, and is situated at a distance of about 11 $^1/_2$ leagues in a north western direction from the Capital of the province, *San Luis.*

The Eastern mountain chain begins with the small Cerro, Aguada, near to San Luis, and runs in a northern direction for a distance of about 16 $^1/_2$ leagues to the Cerro Negro, but inclining a little to the east. Further on the chain inclines still more towards the east until it is lost in the mountains of the province of Cordoba.

The rocks forming these mountain ranges consist for the most part of *gneiss*, *granite*, *porphyry*, *trachite* and other volcanic dykes, very much the same as those found in the mountain districts of all the other mining provinces.

The intrusive porphrytic and trachytic rocks have penetrated the mountain Tomalasta as a centre of action and no doubt these volcanic intrusions have been the principal cause of the elevation of this part of the Cerro and others.

The gold mines of the *Cerro Carolina* are situated on the side of the mountains between Tomalasta and the Capilla of the same village of the Carolina.

On one occasion the writer commissioned one of the Engineers of his official staff to make an inspection of the mines of this province, and in his report he stated that the veins of mineral in the Carolina district "consisted of *crystaline schist* accompanied with mica and conglomerate, this schist being impregnated with pyrites of iron carrying gold, the percentage of which varied according to the natural conditions and position of the mineral vein".

The veins run in a northern and southern direction inclining a little towards the east; but so far it has not, however, been determined how many veins of mineral of the class described exist in the Carolina mountains, nevertheless, if the copy of the map obtained of these mines is to be relied upon, it would appear that four mineral veins have been discovered in the adit which has been driven into the Carolina mines and that of the *Roca de la Cañada—Glen-Rock.* The same

plan exhibits various cross veins of the same class, and according to the written reports of the ancient manager of these mines, the adit, driven from the west towards the east, intersected the four veins of mineral already noted, and the description given of them is as follows.

N.º 1. Vein of mineral 16 feet thick consisting of conglomerates containing gold.

N.º 2. Vein of mineral 30 feet thick, consisting of slate, with pyrites of iron containing gold.

N.º 3. Vein of mineral called *Carolina*, 6 feet in thickness, also of slate and schists with pyrites of iron, containing gold mixed with a small amount of copper, galena and blende.

N.º 4. Vein of mineral called *Blanca*, consisting of conglomerate with pyrites of iron, galena, blende and gold.

It would appear that all these veins of mineral exist in *metamorphic rocks*, and taking into consideration the general character of the mineral veins and surrounding rocks, the opinion has been formed that the formation belongs to the *silurian* period; still, the characteristic fossils belonging to that formation have not been discovered, consequently the particular age of the rocks has not been determined.

The department Engineer, previously referred to formed the opinion that the deposits of mineral containing gold are not true veins, the general evidence derived from the character of the mineral leading to the conclusion that the deposits of schist slate and conglomerate contain no body of ore, but only impregnations of iron pyrites in lesser or greater quantities containing gold.

The great eruptive force exercised in the Cerro de Carolina, by the mountain Tomalasta, caused the elevation of the rocks,

causing much dislocation, cracks and fissures of greater or lesser dimensions, and depth, into which mineral infiltrations entered, filling up the fissures, becoming consolidated and cristalized forming the deposits of mineral as they are now found. The entire zone of these deposits has been estimated to have a thickness of 300 metres. Without doubt, the cross veins in the Carolina mountains are numerous and at the point of their contact with the principal lodes the ancient workings are greater and deeper. This proves the sagacity of the ancient miners, whether Indians or Spaniards and that at these crossing points the deposits of mineral were richer in gold.

It appears that the "*Carolina*", and "*Blanca*", veins proved more constant and yielded the best results.

The official inspection made of these mines offers evidence that there existed a great variation, and that at one point, where the workings were made in a north and south direction, the mineral vein had a thickness of 11 metres, and consisted of conglomerate with pyrites of iron containing a high percentage of gold.

As already noted in Chapter I, the mine "*Carolina*", was worked by the ancient miners as, also, at various periods in modern times.

The mines of this zone were offerred to a London financial house and, in 1883, a company was formed with a capital of £ 50,000, which was afterwards augmented to £ 100,000, the company being styled. "The West Argentine gold Mining Company Limited", with offices in 35 Queen Victoria Street, London.

As already indicated, an adit was constructed from a point on the western side of the mountain and continued in an eastern direction for a distance of 380 metres, which intersected the four principal veins previously described. The vertical dis-

tance gained by this adit to the ancient workings was about 50 metres and, consequently, sufficient mineral was proved to exist to yield a supply for several years. However, the principal workings were confined to the *Carolina* vein, more than to the others which should, undoubtedly, have been thoroughly exploited.

According to reports, formerly published, the mineral veins, N.° 2, yielded, by assay, as much as 729 ounces of gold per ton and, also, that assays of mineral obtained from the *Carolina* vein yielded from 2·719 to 8·491 ounces of gold per ton, but evidently the samples of mineral assayed with the above yield were selected and, therefore, is no guide as to the average percentage yield of large quantities of mineral.

A more reasonable notice is that given some time since by one of the managers of this mine, which was to the effect that 600 tons of mineral extracted from these mines yielded at the rate of 1·644 ounces of gold per ton. It is stated that at this time the mines yielded 120 tons of mineral per month. The same manager, however, stated that the yield of the whole of the veins amounted to no more than 0·5 ounces per ton, when the poorer minerals had been discarded the yield of the selected parts was at the rate of 1·208 ounces of gold per ton.

However, the various statements coming from the different managers who conducted mining operations in these mines, are at variance.

At the time of our official inspection, there existed at a distance of about 1000 metres from the entrance of the adit, a small establishment for the to treatment of the ore.

The mineral was first reduced in a stamp mill and then the gold was obtained by the ordinary method.

In the establishment indicated, only about 300 tons of mineral per month could be treated so that it was of limited extent.

The Mine Glen Rock

The mineral land occupied by the company of this name, is situated to the north of the *Carolina* property, and appears to be a part of this large concession made by the provincial government, which extends over a larger area than that provided for by the then Mining Code of the Republic or, the Ordenanzas de Mexico.

The mineral veins in the *Glen Rock* property are the same as those previously described as existing in the "*Carolina*" mines. An adit has been driven in the Glen Rock, but it does not appear that at the time of the official inspection before referred to, that any extensive workings had been carried on in these mining lands.

At a general meeting of this company, in London, one of the Directors stated, according to a public report.

" We know that the section, or *Glen Rock*, has an extension " of 304 yards, N.º 2, has 700 yards, our property called " *Buena Esperanza*, N.º 3, is called *Buena Fe* and has 290 " yards, N.º 4, the *Brillante* has a length of 285 yards, and " also others at the southern limits. Thus there is sufficient ex- " tension of mining land for a large number of companies if " the necessary capital could be procured to commence work- " ing. Three companies have already made us offers to ac- " quire this mining territory. "

There seemed to have been a question referring to some property which appears to have been claimed by this Company in the *Cerro Valle de la Cañada Honda* and 7th. Department, and then to clear up this point the report proceeded " Well, the *Cerro Valle* really was a registered compa- " ny, and undoubtedly we had an offer to work the *Cañada*

" *Honda* part of our proper reef-claim. We should have receiv-
" ed a certain number of shares: the time for this regulation
" terminates at the end of this month, afterwards we should
" receive a certain percentage in shares or in money.

" The 7th. Department was also an affair or negotiation be-
" tween ourselves and interested parties. This 7th. Department
" tis a very valuable property and at present we are working it
" *Encantadora* upon a small scale in order to secure the pos-
" session. Already it has been insinuated that we should have
" great pleasure to take £ 20,000 in shares in a company form-
" ed with a capital of £ 80,000, and a capital of £ 50,000 for
" working expenses. We should like very much to enter upon
" a distribution with the half paid down."

It has been reported that what has been cited above formed part of a speech delivered by a Mr. Hopwood, president of this company.

It would appear that the government of this province had granted a concession of a very large tract of mineral land, much larger in fact than that provided by the mining laws ruling in this Republic, and some of the shareholders of the company felt that the company was not on safe ground; because one of the Directors stated.

" We have our concession under the authority of the pro-
" vincial government which is equal to an act of Congress of
" San Luis. The law of mines which now rules do not affect
" these concessions in the least degree.

" Our concessions date from a period anterior to that of the
" Mining Code, and I have to state that the Legislative body of
" San Luis has recognised and confirmed these concessions
" since the promulgation of the new Code of mines, and for
" these reasons we are absolutely secure. The concessions gi-
" ves us the right to acquire properties according to the code
" of mines, and no one can enter into our territory. We have

" some years to examine the properties and determine whe-
" ther we shall take them up or not. "

Whether this concession is legal or not may be determined from the discussion which we shall advance in the chapter dedicated to the Mining Laws of this Republic.

The evidence presented in the above quotation is conclusive and proves that the area of the concessions referred to was in excess of that provided by the mining laws which ruled in the Ordenanzas de Mexico up to the 1st. May 1887 and afterwards by the actual Code of mines, which then commenced to take effect. It is, therefore clear that the original company i. e., that of the *Carolina*, directed more attention to the sale of their concession than to a formal and continuous exploitation of the mines.

The same remarks apply to some other companies which had operated in this district.

On the 18th. May 1894, a syndicate or company was formed in London under the name of "Argentine Concessions Limited" to acquire through the "San Luis Mining Syndicate Limited" a lease of the properties of the "West Argentine Limited" (now Phoenix Limited) and to take over the machinery, plant and buildings belonging thereto with an authorised capital of £ 30,000 in 300,000 shares of 2 shillings each. The capital issued amounted to £ 25,000.

The works of the *Carolina* were taken over by and Mr. F. Döering, the manager who commenced to extract mineral from the *Carolina* veins and to mill the mineral, about it is believed November 1897.

The ore was extracted from the Carolina adit upwards for a distance of about 50 metres, when the old workings were found. About 18 to 25 tons of ore was extracted daily and passed through a four headed stamp mill. The produce was calcined and then amalgamated in the usual way.

One of the Engineers, Mr. J. Sheredon Russel, who had charge of the milling, informed the writer that the best milling produced 5 kilos of fine gold in the space of 22 days. Taking, therefore, the produce of mineral at the maximum output per day at 25 tons, as much as 550 tons of ore would have been treated in the time mentioned and this would give 0·604 of an ounce of gold per ton of crude ore.

In general the produce from the veins of mineral in the "*Carolina*" mine, is estimated to have been at the rate of one half ounce of gold per ton.

Mr. Russel, remained at the mines a period of 1 $^1/_2$ years and after he left, the manager, Mr. Döering, installed a small plant to enable him to apply the *Cyanide process*. He had four 50 ton vats of the Frazer and Chalmer's type; but there is no evidence to prove that he obtained any great success by this mode of working. Not long afterwards, the mines were abandoned.

The companies which have been identified with that of the "*Carolina*", and the mines claimed by it, have such a confused history that it is difficult to disentangle, and to give a detailed account of their proceedings; but, according to published notices, there have been several reconstructions down to 1899.

It would appear that the whole of the mining properties of the "West Argentine Gold Company's, Limited", had been leased to the "Argentine Concessions Limited". The original company is entitled to one tenth part of the annual profits obtained by the "Argentine Concessions, Limited", after deducting a sum sufficient to pay 5 $^0/_0$ on the paid up capital of the Concession company. A final call of six pence per share was due on the 30th November 1898, and it appears that 42,850 shares were forfeited.

The first accounts were made up to the 30th June 1898, and submitted in August. There were calls in arrear to the

amount of £ 4.657. Debtors owed £ 914, and Creditors £ 6,647 The debit balance in London and expenditure accounts amounted to £ 3,695. Cash in hand £ 775. A receiver was appointed in February 1903.

According to these statements, derived from public notices, it would appear that this company's affairs may be expected to be in, or approximating liquidation, at that date.

It is believed that the mines and concessions of mineral land made to the old *Carolina* Company, have not been conserved according to the provisions of the present Code of Mines.

Gold Washings in the Cañada Honda.

This mineral district is situated at a distance of about 20 leagues from the town of *San Luis*, and at some 2 leagues from the "*Carolina*". It occupies a nearly level camp between the mountains, bearing in the general direction of north and south. It has been calculated to extend for a distance of 1700 metres in length, and 170 metres in width.

The rocks which form the base of the "*Cañada Honda*" consist of granite, gneiss, mica schist, etc., etc., exactly of the same nature as those of the surrounding mountains. The auriferous deposits of sand vary in thickness, but the average depth from the surface may be taken to be from 15 to 25 feet. The auriferous deposits themselves consist of a variety of beds of different thickness formed principally of sand and clay mixed with other debris, all of which have been denuded and carried from high levels and deposited in the form described. Many persons have worked for gold in different parts of this district, at intervals for a long period of time. It has been reported by those who have worked in this locaiity that

the principal auriferous deposit is confined to a comparatively narrow zone for the entire length of the *Cañada Honda;* but the exact width of the zone referred to has not yet been satisfactorily determined.

It has been estimated that the average produce did not exceed from 0·5 to 0·70 of an ounce of gold per ton; but it is natural to suppose that some parts of the auriferous deposit would yield more.

At a former period, the works are said to have yielded 1·600 ounces of gold at a cost of extraction of £ 1 7^{s} 0^{d} per ounce; and it has also been calculated that more than 300,000 tons of auriferous sand could be treated, which would yield 30,000 ounces of gold. That would be a greater yield per ton than formerly estimated.

The great drawback in the *Cañada Honda*, is the comparative small quantity of water available for mining operations. If therefore, at any future period it is proposed to carry on mining operations in this locality on a large scale, it would be necessary to build dykes where the water could be collected and used in dry seasons.

The most formal attempt to exploit the auriferous deposits of *Cañada Honda* and others in more modern times was that initiated by a London Company, under the management of the late Mr. Randolf Mellor, who expended about £ 15,000 without obtaining adequate results. The Company seems to have abandoned mining in this region, although Mr. Mellor must have believed in the productive qualities of the auriferous deposits, for, we find that he obtained the original concessions in his own name and carried on mining for a considerable time. Finally he sold his rights to another party with whom his son was afterwards identified.

What progress or benefit this new company obtained is unknown, but ultimately it abandoned the undertaking.

The writer has dwelt upon the question of these auriferous deposits at considerable length, for the express object of informing others of the conditions of the case, as also to exhibit to them the necessity of caution before entering upon such a mining scheme.

However, he is far from condemning these auriferous deposits, for it is quite possible that there exists richer ones quite overlooked.

The Gold Placers of the Rio de la Carpa

The auriferous deposits forming this mining camp run parallel with and at a distance of about a league in an eastern direction from the *Cañada Honda*.

Some workings have been carried on in this small field, and it is reported that on one occasion a few miners extracted gold to the value of 1000 paper dollars per month, but, in modern times, it would appear that the produce was much less.

The auriferous sand, or debris, is of the same character as that of the *Cañada Honda*, with the exception that the rounded stones carried down from higher levels and deposited are less abundant. The water in this district is also scarce.

It has been estimated that the yield of gold in this district is not less than that of the *Cañada Honda*, but mining has been carried on by poor miners employing only ordinary methods for the extraction of the gold, consequently, their operations have been limited to a small scale and, as far as possible, in a clandestine manner for the reason that the miners are under the impression that the West Argentine Gold Mining Company, pretend to claim this district as being included in the large concession of mineral land granted by the San Luis government, previously referred.

Under such conditions, therefore, it is not surprising that no other company has ventured to exploit this auriferous camp or determine its productive capabilities and commercial value. No doubt such a real, or pretended claim, is exceedingly injurious to the general mining interests of the province in question.

The provincial government would do well to clear up this question, so that when the public directed its attention to the exploitation of this zone, it would not be molested by those who do not possess mining rights according to the code of mines.

The Gold Washings of Cerritos Blancos

This locality is situated at a distance of about two leagues to the north east of the "*Carolina*", and to the north of the "*Cañada Honda*", and in it there still exist evidence of ancient washings.

The altitude of this district is about 1,660 metres above sea level, and the gold deposits appear to extend to a distance of two kilometres. A large number of ancient pits and excavations exist, but it is uncertain who the miners were that made them.

The mining operations were confined to a bed of auriferous sand below the vegetable soil, and one of the former governors of this province reported that, on one occasion, as many as 2000 miners were occupied in washing for gold in this region and that, ultimately, due to the scarcely of water, it was customary to transport the auriferous sand to the nearest stream of water, where the gold was extracted. In some cases, however, the miners waited for the rainy season before commencing operations.

For some reason or another, such workings as those described ceased and the pits filled with debris. The report of the governor, previously referred to, affords no information as to the precise time when the 2000 miners were employed in mining in this district, nor the amount of gold extracted, consequently, we are unable to form any opinion as to the value of the auriferous deposits in the region referred to. It is possible, that its apparent small extension would not induce any formal company to enter upon mining operation there.

All the streams of water which are found within 25 square leagues, and which rise in the surrounding localities of "*Carolina*", "*Rio de la Carpa*", *Cañada Honda*", etc., contain auriferous sands in various places.

From all that has been advanced in this chapter, it is evident that gold in lesser or greater quantities exist over a large extension of land, but it is doubtful whether the conditions under which such deposits are found, and the circumstances and difficulties surrounding the question, would induce any formal and continuous exploitation.

It is a well known fact that after the season of heavy rains, the miners leave the *Cañada Honda, Rincon del Cerro* and other places to search for gold, and always with more or less success. This plan is, also, followed in all parts of the Republic where gold exists.

The mine "Viraorca". This mine is situated in the lower part or eastern declivity of the mountains of this province, and it has an elevation of about 100 metres obove the general level of the camp.

The formation of the mountain, in which this mine exists, consists of *metamorphic* rocks, and the vein of mineral in the mine is enclosed between walls of gneiss, and it is possible to distinguish the different decomposed rocks here and there, and their transformations, in a very satisfactory manner.

The vein of mineral runs in a northern and southern direction, inclining towards the east at an angle of 12 degrees, with a thickness of about 55 centimetres.

Various excavations have been made upon the vein, which was found to contain a large amount of oxide of iron, carbonate of copper, and sulphides of copper with quartz and dottings of native copper.

The workings in this vein extended to a depth of 35 metres which is now full of water.

We have already given an account of the exploits of Mr. Livingston, and his mining and smelting operations, in Chapter II.

The general opinion is that this is a very important mine.

The Fifth Department

It would appear, that, a great deal of the so called *exploring* has been done, but it does not seem that many important discoveries have been made.

The mine "*Angelita*". Practical miners inform us that this mine was first discovered and exploited by the previously mentioned Mr. Livingston, who appears to have continued mining in it from 1869 to 1876.

The mineral vein consisted of pyrites of copper and iron, containing gold and silver, and the produce was transported to a small establishment of fundition which consisted of a reberbatory furnace. The mineral was comparatively poor, i. e., 4 °/₀ of copper, with 8 ounces of silver, and a little gold per ton.

The water which entered the mine was extracted by pumps moved by horses, but these appliances were not sufficient to keep the mine dry.

It was situated to the south east of the Village of *San Martin,* and the mine seems to have been completely abandoned in modern times. Its altitude is about 1,100 metres above sea level.

The vein is enclosed by walls of granite, and has a direction of about north 40° east, and may be traced upon the surface for a distance of 600 metres, at the termination of which it is lost, but comes to the surface again at a place called *Moromas,* where other excavations have been made upon it, but here it has thinned out to 0·30 centimetres.

Mine San Francisco

Near to a small village of the same name, copper mines exist which have been worked to a considerable extent in ancient times: some say by the Jesuits, and others by Chilian miners, many years since.

The mines are situated at a distance of some 33 leagues from the town of *San Luis,* 20 leagues of which can be traversed by mules, or to the village of San Francisco, and from this place to the mines the distance is about 2 $^1/_2$ leagues.

Recently, these mines have attracted some attention, and a native capitalist consulted with the writer, in reference to the propriety of commencing the reopening and exploitation of them.

It was reported that at the surface, the vein of copper ore had a thickness of 25 centimetres, yielding 59·80 °/₀ of copper, continuing in this condition to a depth of 15 metres; but at 27 metres in depth the vein had divided into a serie of small threads of the same quality as it had near to the surface. The deepest point reached by the ancient miners was 50 metres, and, at this point, the copper lode was 2 $^1/_4$ metres thick, but much poorer in quality.

A sample of 18 tons of ore was recently extracted, and yielded 17 °/₀ of copper and 17 grains of gold per ton. A second sample of 12 tons, yielded 26·50 °/₀ of copper, and 30 grains of gold per ton.

Another sample of 8 tons, of poorer qaality of ore yielded 17 °/₀ of copper and 40 grains of gold per ton.

This ore realised in the market from 113·15 to 190 paper dollars per ton.

Various other copper veins at the surface yielded as follows:

Copper %	Gold %
4·40	0·00050
6·80	0·00030
3·60	0·00180
4·00	0·00080

A general analysis of this mineral has been given as follows:

Copper	16·700 °/₀
Iron	4·210 "
Gold	0·006 "
Sulphur	9·094 "
Gangue	70·000 "
	100·000 "

The gold is at the rate of 2·15 ounces per ton. Other samples of mineral, extracted from this mine, assayed at the rate of 29·06 °/₀ of copper without gold or silver, the gangue having descended to 61·72 °/₀.

It was estimated that the profit would amount to 149,386 paper dollars per ton.

All the appearance are good, but there was no guarantee as to the quantity of copper ore which could be extracted from the mine.

The workings placed upon the copper lode consisted of three pits, one of 60 metres in depth, a second of 25 metres, for ventilation, and a third of 12 metres with galleries which communicated with the pit at 68 metres.

It cannot be expected that a practical and experienced miner like Mr. Livingstone was, would have expended his capital in making excavations to such an extent if the thickness of the copper lode was not more than 30 centimetres.

It is, therefore, reasonable to infer that it was a great deal thicker, besides, we have it stated, that the mineral extracted was rich and found in masses. As previously indicated, these mines were abandoned for the want of adequate funds.

The mine "*Esperanza*". This mine is situated at a distance of about 6 leagues eastward from the village of *San Martin*, and was discovered by Vicente Gonzalez, who worked it to a limited extent in the year 1881. The vein runs in a northeast and southwest direction, and at the surface it had a thickness of 1·50 metres with variations, in the depth. It consists of carbonates and pyrites of copper, with oxide of iron in great abundance.

This mine was soon abandoned, and the mineral extracted remaining at the surface where it was first deposited.

At a distance of about 200 metres another excavation was made upon the same vein of mineral, and it was found to contain auriferous decomposed ferruginous quartz.

The locality of this mine is situated at an altitude of about 1000 metres above sea level. It would appear, that no low level could be found from which to drive an adit to drain the water from the mine.

The District of "Mina Fortuna" or Santa Barbara

The opinion of the Engineer, sent by the writer to examine the mines in this province, is that the mines known under the name in the above heading, merit great attention.

The mine "*Fortuna*", is situated to the northeast of the sierras of San Luis, parting from the *Rincon del Carmen*, at an elevation of about 40 metres above the surrounding camp, and at an altitude of about 1000 metres above sea level. The mineral vein has a thickness of 0·60 centimetres, and runs in an eastern and western direction inclining about 15 degrees towards the south. The walls of the vein consist of granite and gneiss, very hard and compact.

The contents of the vein consist of galena with fine crystals, a rare occurrence in this country, also of copper pyrites, carbonate of lead and quartz.

This mine was worked at the surface, in remote times, probably for the silver contained in the galena.

From 1870 to 1881, workings were carried on in this mine, but only at short intervals of time.

During the latter year named, a Buenos Aires company obtained from the government of the province of San Luis the exclusive priviledge to exploit the mines, etc., in all the extension of the mineral land included in the 5th Department.

This company commenced exploiting some galena mines, reducing the mineral in a reverbatory furnace. Three pits of 22, 43 and 74 metres respectively, were sunk upon the vein of mineral in the "*Fortuna*" mine. It appears that about 200 tons of mineral were extracted and reduced in the same reverbatory furnace at a place called Talita, situated at a distance of about 7 leagues fron the mine.

Some few years afterwards, workings were again placed in this mine, and a small amount of mineral extracted, but mining operations in it appear to have ceased soon afterwards.

The mine "Santo Domingo". This mine is situated at the eastern limits of the "*Fortuna*", and has been located upon the same vein of mineral. A company of poor miners commenced to work this mine in 1882 with a capital of 1000 dollars, but mining operations soon ceased.

The vein of mineral consisted of galena, carbonate of lead, pyrites, and peroxide of iron, the yield being at the rate of 40 °/₀ lead, and 100 ounces of silver per ton. After extracting about 15 tons of mineral, it was found that the vein was too thin to yield a profit at that level or zone, and was, consequently, abandoned.

The mine "*Tricolor*", is situated on the estate of D. Francisco Pereira, at a distance of about 2 leagues in a western direction from the mine "*Fortuna*", and in it two thin veins of mineral occur, consisting principally of carbonate of lead, peroxide of iron, and auriferous quartz.

A large number of other mines of a similar class exist in this district, among which may be mentioned those called, "*Piedras Bayos*", "*Huerta*", "*Sala*", "*Alsa*", "*Encantadora*", "*Descubridora*" and others.

MANGANESE DEPOSITS

A deposit of this mineral exists at a place called *Piedra Parada Grande*, not far from the mine "*Descubridora*", previously mentioned. The mineral has been denominated by some persons as a *proto-peroxide of manganese*, and yields a high percentage of metal. On one occasion the mine was worked upon a small scale for a company from Buenos Aires, and about 100 tons of mineral extracted.

The deposit appears to be limited to an area of about 30 square metres, surrounded by gneissic rocks. At the surface, the mineral was mixed with quartz and other elements.

Several persons have attempted to work this mine on various occasions, but soon found it convenient to abandon the enterprise.

Other deposits of manganese have been reported as existing in the same locality, but there is no information to hand referring to their productive capacity.

The galenas, obtained from this province, have frequently been assayed, and the silver determined to be at the rate of 0·1 %, 0·14 %, 0·22 %, 0·30 % and 0·69 %, with variations. Some of the determinations were as low as 0·04 % and 0.08 % of silver.

The following analysis may be taken to represent the type of iron ore found in this province.

Peroxide of iron	23·41 %
Protoxide	64·20 "
Manganese	0·80 "
Magnesia	2·35
Titanic acid	3·64 "
Silica	4·20 "
Alumina	1·40 "
	100·00 %

The elements, forming this analysis, prove that the iron is of excellent quality, and, if it could be found in large quantities, with all the surrounding circumstances favourable, with sufficient combustibles and cheap and rapid transport, an establishment of fundition could be installed, and a handsome profit obtained.

Doctor J. J. J. Kyle, the gentleman previously referred to, was good enough to furnish the following analysis of a typical sample of the manganese ores of this province.

Sesquioxide of manganese. . .	50·50 °/₀
Bioxide of " . .	27·79 "
Magnetic oxide of iron . . .	7·49 "
Alumine	2·00 "
Lime.	1·00 "
Magnesia	0·52 "
Silica	8·00 "
Water	2·70 "
	100·00 °/₀

The Doctor stated that this would give 55·59 °/₀ of black oxide of manganese.

MARBLE QUARRIES

The marble deposits are situated in a small table land which is a prolongation of the sides of the *Cerro Rosario*, in the Department of *Pringles*, and at a short distance from the cart road passing through the mineral district of the *Carolina*. The beds of marble exist upon the Estate called *El Pantano*, property of Don Ines Lopez.

The marble beds are almost horizontal at the surface, with a few inches of soil covering them, consequently, there is no difficulty in opening quarries for the extraction of slabs of marble of any desired dimension.

Up to a recent date, three thick beds of marble had been discovered in one of the quarries, and they extend over a large area, the extension of which, however, has not been determined.

The marble has attracted great attention in Buenos Aires, resulting in the formation of a small company for its exploitation.

At the time of the official inspection, the Engineer reported that a large number of blocks of marble, of different sizes, had been extracted and deposited at the mine, amounting to 1000 tons. At this time the quarries were managed by inexperienced persons who employed powder to dislocate the marble slabs resulting in an enormous waste.

The marble has a pale green base, with veins running through it in various directions of a red, brown and yellowish colour, varying in shade, giving to it a beautiful appearance. The marble is clear and semi transparent, takes a beautiful polish, and has been very favourably received in Europe for the manufacture of all kinds of ornamental works and articles, and is said to be in much request.

Samples of this *onyx-marble* will be exhibited at the San Louis exhibition.

Another deposit exists upon the property of Señor Alvarez, situated at a distance of about 1 $^1/_2$ miles in an eastern direction, but, for some reason or another, the marble has been considered, by some persons, to be inferior to that previously described; but the writer is of an opinion that this supposed difference has to be proved in a more practical manner than that of mere assertion. Possibly, the fear of competition has something to do with the appreciations indicated.

Various other valuable minerals exist in this province, such as Wolfram, Mica, etc.

CHAPTER XIII

Mines and Mining in the Province of Cordoba

This province is bounded to the west and north west by the provinces of San Luis, La Rioja, and Catamarca; to the north by that of Santiago del Estero, and to the east, south east and south, by the provinces of Santa Fé, Buenos Aires and part of the Pampa Central.

It has a very irregular form, is a central province, and extends over an area of 161,036 square kilometres, the favourable situation of which, conduces to an extraordinary healthy and temperate climate.

The mountain chains existing in this province are comparatively low, and ramified to a large extent, consequently, the topographical features are varied.

The valleys are fertile, well watered and wooded, and in the various districts, some of the most beautiful, deversified, and picturesque scienery may be found, for which reason it is the favourite summer resort for tourists, men of science and letters, and others requiring rest, peace, and the invigorating effects of a clear atmosphere, with a good and temperate climate, in fact, in this province the painter has ample scope for the employ-

ment of his brush, the poet for a time of quiet recreation, expansion of his inventive genius mystic and divine lore; the mineralogist in his researches for curiosities, whilst the geologist may revel in his endeavour to unravel the mysteries, age and structure of the rocky formation, and the financier and engineer, can enjoy excursions to the various mineral deposits which nature has distributed with a lavish hand throughout the neighbouring districts. The tourist and habitual visitors have the opportunity of every kind of diversion without irksome restrictions.

It is the nearest mining province to the capital of the Republic i. e., Buenos Aires, and to the port of Rosario, and for these reasons ought to receive more attention from those who are searching for mines with a bona-fide intention of introducing capital for the exploitation of the mineral resources of the country.

The city of Cordoba, is noted for its seat of learning, its high class Divinity school and National Observatory of Astronomy; the central and authorized guardian of the first time meidian of the Republic, to which all the others are referred.

The height of the city above sea level has been variously estimated; but it may be taken to be 385 metres.

The distance, in a straight line and in a westerly direction from the city of Cordoba, to the nearest mountains may be estimated at about 5 leagues.

This first chain of mountains generally run in a northern and southern directions, with ramifications. The whole mountain systems of this province cover a considerable area.

In the first chapter of this work, it has been stated that mining was carried on, at intervals, over a period of many years, and that the same obstacles had occurred here as in other parts of the Republic i. e., the want of adequate capital for a

permanent development of the mining resources. However, these observations must be taken in a general sense, and do not include exceptional cases. Experience teaches, that in all mining districts, rich and poor mines are to be found, and, consequently, as in former times, if these are selected in an indiscriminate manner, without proper knowledge of what is good and what is bad, the result, in all probability, would be failure. It is, therefore, a misfortune when inexperienced persons propose the formation of a company for the exploitation of mines which did not possess the necessary conditions to yield a profit upon the capital invested in them. Unfortunately, this province has suffered to an enormous extent from such mining adventurers, but we think that in the future more caution will be excercised in order to prevent other failures.

Failures due to bad management and poor selected mines, have a prejudicial effect upon the minds of others, and is a great detriment to mining progress; but, when good mines present themselves in the same district where others have failed, and after scientific and practical invistigations are found to possess commercial value, an adequate amount of capital should be invested in them.

The bad speculations which have occurred in this province is, by no means, a reason why, in the future, many mines may not be discovered capable of yielding adequate benefit.

The prosperity of this province in all other branches of industry and agriculture, together with the facility offerred by the systems of railway transport to the nearest ports, are advantages of great value in assisting the development of the mining industry in this fertile province.

Many veins of galena exist in the districts of this province, and from published data representing the yield of metal obtained from minerals extracted from the galena mines in the following countries, we may make a sufficiently fair compari-

son of the productive capacity of the galena mines of the province of Cordoba.

France	48·1888	Ounces of silver per ton.
Germany . . .	49·7888	
Belgium	59·4000	
Switzerland . . .	13·6100	
Italy	5·6240	
Sardinia	10·6560	
Spain	59·4000	
Average product.	33·9533	

It has been calculated that the veins of galena existing in the mining districts of this province, would yield an average of 104 ounces of silver per ton, which, if verified upon a large and continuos exploitation, would produce 44·60 ounces of silver in excess of the largest yield in Europe i. e., of Spain.

The writer has no reason to doubt the estimate which has been presented for his consideration, and noted above, but as the question is of great importance to the public, the province, and Republic at large, he has been induced to give the following table which represents analysis made in the Laboratory of the National Department of Mines and Geology of samples of galena obtained from the mines of Cordoba.

Per cent of silver	Ounces of silver per English ton	Per cent of Lead
0·81	290·30	71·30
0·51	182·78	42·50
0·48	172·03	61·00
0·59	211·46	45·00
0·73	261·63	54·50
0·63	226·79	48·50
0·27	96·77	10·50
0·43	154·11	44·00
0·20	71·68	36·24
0·25	89·60	75·90
0·44	457·96	71·00
0·29	103·94	64·00
0·48	172·03	51·00
0·61	218·62	65·50
0·21	75·26	12·88
Total . 6·93	2484·96	753·82
Average . 0·46	165·66	50·25

This table demonstrates in a clear manner that the produce of silver per ton of crude mineral, is in excess of that previously given. The samples were submitted by some of the miners who have worked the galena veins in this province. However, samples entering a laboratory, situated at a long distance from the mines, cannot have much bulk, besides such may not represent the general output of a mine.

However, sufficient has been said to prove that the galena mines are worthy of considerations.

The favourable results which in some cases have been already obtained, with small capitals and inadequate means, are sufficient to demonstrate what may be done in the future supposing the mines were exploited in a proper manner and upon a large scale, in conjunction with modern establishments of reduction for the different classes of minerals of this province.

The elements contained in the following table, were deter-

mined by Doctor J. J. J. Kyle, and the samples of mineral were obtained from the mines indicated below.

Name of Mine	Number of ounces of silver per ton	Percentage of Lead
Niño Dios	306·00	71·30
Jose Maria	144·90	42·50
San Antonio	179·40	45·00
Vein Jeronimo.	170·00	54·00
Vein new government . .	170·00	51·00
San Agustin	174·00	34·32
Eufemia.	113·00	71·00
Vibora	132·80	—
Overo Muerto.	104·40	68·00
Dos Amigos	174·00	—
San Miguel.	165·00	—
Mercedes	93·00	—
Mina Nueva	144·00	—

The determinations in the above table confirm those previously given.

A large number of veins, consisting of argentiferous lead, exist in various parts of *Guaco* and *Argentina*, but a greater number of mines have been conceeded in the former district than in the latter although of equal importance; but, in both localities, many of the galena mines have not been proved. In no case have any of these mines been worked to a greater depth than from 40 to 50 metres.

In certain localities, the galena is mixed with blende and antimony, as was the case with the ores extracted from the well known mines "*Rara Fortuna*", "*Buena Fortuna*", "*Garibaldi*", and "*Santiago*", which mines yielded silver as high as 251 ounces per ton.

Mines, such as "*Bella Americana*", "*Mogote Blanco*", "*San Pedro*", and others, had a variable yield up to 250 ounces of silver per ton.

The general yield from some of the mines in the district of *Guaco*, was at the rate of 107·52 ounces per ton, and the poorest ore yielded at the rate of 53·76 ounces per ton. Mineral has been extracted from some of the argentiferous lead mines yielded from. 8 °/₀ to 10 °/₀ of silver.

The mines "*Buena Ventura*", "*San Jorge*", "*Tronco Negro*", "*Bellena*" and "*San Miguel*", are a few among many others which have yielded mineral assaying as high as 1·0 °/₀ of silver.

It has been reported by competent persons, that the mines indicated are capable of yielding an abundance of mineral, and that they were abandoned on account of the large quantity of water entering into them, and for the want of proper means of extracting it.

The best known mine in the district of *Guaco*, is the "*Asuncion*", which has been worked to a depth of 80 metres. The mineral vein in this mine runs in a southeastern direction and varies in thickness from 12 to 18 inches.

The mineral vein in this mine was found to increase in thickness with the depth.

At one time, as many as 80 men were employed in the mine.

The galena mining district of *Argentina*, is situated at a distance of about 16 ½ leagues from that of *Guaco*, and extends over a considerable area, ending in *Ojo de Agua*, *Roca* and *Guasampa*.

The mines of this district contain more silver and less lead than those in the *Guaco* district, which constitutes a favourable condition, besides the mineral is very abundant.

One of the best known mines is that called "*25 de Mayo*", which contains various galena veins running in a north easterly direction. The experimental works carried on in it did not exceed 10 metres in depth, and the mineral extracted was

ferruginous, assaying 0·50 °/₀, or at the rate of 179 ounces of silver per ton.

However, sometimes the yield assayed as high as 1·0 °/₀ to 2 °/₀ of silver, or from 358 to 716 ounces per ton.

The mine "*Santa Cruz*", also produced mineral assaying from 0·40 °/₀ to 3·50 °/₀, or from 143·36 to 1254·4 ounces of silver per ton; but this was limited to a small quantity of ore extracted.

There are various other mines in this district, but for the want of a formal exploitation, there is no date to hand by which their value could be determined.

There exist a large number of mines in the mineral district of "*Cruz del Eje*", one of which is called "*Niño Dios*", situated in the Cerro de *La Trilla*, at about 20 or 30 leagues, more or less, from the city of Cordoba.

One of the principal veins of galena in this mine runs in an easterly and westerley direction, and averages 22 inches in thickness. It consists of carbonate of lead, mixed with sulphide of lead and silver. Near to the surface, the vein contained blende and quartz, but, in the depth, these elements diminished, and the vein augmented in thickness, as, also, in richness. The workings in this mine were carried to a depth of about 45 metres, but the entrance of water prevented further progress.

Afterwards an adit, 292 metres in length, was driven into the mine in order to intersect the vein of mineral and drain off the water.

It appears that several veins were discovered in this mine, the general thickness of each being 24 inches. Assays of the mineral extracted from this mine have been given in the preceding table. However, afterwards, when the workings attained greater depth, the mineral yielded as high as 8·43 °/₀, or at the rate of 3,021·3 ounces of silver per ton. It is reported

that the mineral in the mine is abundant, and, on one occasion 118 tons extracted from it yielded 157·6 ounces of silver per ton, showing that the yield is variable. The last cited yield would appear, however, to be an average produce.

The galena mineral extracted from the celebrated mine "*Rara Fortuna*", has yielded mineral which, by assay, gave 259 ounces of silver per ton, and 54·5 °/₀ of lead.

Mineral extracted from the mine "*San Miguel*" yielded 165 of silver, as exhibited in the preceding table, but some of the mineral extracted ran as high as 20 °/₀ of silver; but the quantity of mineral of this grade was limited.

Various other galena mines exist in the mountains near to the small villages of *San Marcos*, *San Carlos*, *Calamuchita* and others, but these mines have not been proved to the same extent as the ones described.

In fact, the various mining districts of this province contain many galena veins which might be exploited to advantage, and one is led to conclude that at no very distant period, the development of this industry will be undertaken upon a large scale.

The various assays which we have presented, is a proof that the galena veins are sufficiently rich to warrant the necessary expenditure of capital for their exploitation, but any such scheme must, however, include one or more establishments of fundition for the ob ect of reducing the ores. It would, also be necessary to introduce modern processes in mining and smelting, as, also, an adequate and economic administration.

Copper Mining District of Calamuchita

This mining district is situated at a distance of about 16 leagues to the southwest of the city of Cordoba, and in it various copper mines exist, some of which were exploited many years since. The remains of an establishment of fundition still remain, which formerly belonged to Mr. Samuel Lafone, and abandoned as far back as 1859.

The copper mines which Mr. Lafone worked, were closed on account of some conflict which ended in a law suit, referring to disputed right of possession of the mines in question.

One of these mines was known by the name of *El Tio*, and was worked to a depth of 41 metres, at which point the lode had a thickness of 1·33 metres; but at the surface its thickness was no more than 91 centimetres.

The mineral extracted consisted of sulphide of copper mixed with ferruginous matter; but as is usually the case, at the surface and to some depth, the vein of mineral consisted of carbonate and silicate of copper; but a change took place at 12·80 metres in depth, introducing sulphides.

A parcel of mineral of 80 tons, extracted from this mine, yielded at the rate of 15 °/₀ of copper.

Two principal veins exist in the mine i. e., *Urquiza* and *St. John*, with a distance of 17 metres between them. There are, also, two cross lodes in this mine, one of which is rich in silver. The one which was proved to the greatest depth, yielded at the rate of from 15 to 18 °/₀ of copper.

Further towards the east, exists three other copper lodes running parallel to those already described in *El Tio*, and to the south of the lode *St. Juan*, were discovered, from which copper ore of a high percentage was extracted.

The vein Urquiza was exploited to a depth of 60 metres, and yielded black oxide of copper.

At a short distance from the mine "*El Tio*", is the mine "*Tacura*", which has been worked also to a depth of 60 metres, but it has long since been filled with water. The vein in this mine, also yielded black oxide of copper.

According to report, at a distance of about 4 leagues to the north of the mine "*Tacura*", is located the mine "*Tauro*", the vein of mineral in which has a thickness of 33 inches, upon which workings were made to a depth of 46 metres; but, the quantity of water which infiltered at this depth, prevented further workings. The copper ore extracted, gave a higher percentage than that in the mine "*El Tio*".

In the adjoining district, or at a distance of about a league from the mine "*Tauro*", many lodes have been discovered, containing copper, some of which have been considered of great importance. The mineral in these lodes consists of carbonates, oxides and silicate of copper.

At a distance of about 18 leagues to the west of the *Potrero de Garay*, exists the mine "*Mercedes*", and in this locality many lodes containing copper have been discovered. The mineral is of the same class as that of the *El Tio*.

Other mines of the same class are called "*Veta Virgen*", "*San Antonio*", "*Machito*", etc.

In the low mountains; close to this locality, exist a large number of veins of mineral crossing one another in various directions, all of which present conditions suitable for a good exploitation. However, no sufficient data is to hand by which the commercial value of these lodes may be determined.

Doctor J. J. J. Kyle, visited some mines of copper, situated at some leagues distant, to the south, of the mine "*El Tio*", in the mountain called *Colorado*, and there a galena vein was discovered, 33 inches in thickness. The vein contained galena

mixed with carbonates and silicate of copper, in a base of quartz, which contained gold and silver. No works had been made upon this vein, but the Doctor obtained samples from it which gave the folloving results:

NUMBER OF SAMPLES	Percentage of copper	Ounces of silver per ton	Ounces of gold per ton	Percentage of lead
1	15·66	64·0	0·80	—
2	44·18	156·0	—	—
3	3·20	22·5	0·90	—
4	22·56	22·6	0·77	—
5	7·46	34·6	0·49	58·70
Average. . .	18·61	59·94	0·74	

This shows exceedingly well, and if 3 $^1/_2$ tons of crude ore were treated and reduced to regulus, it would produce 65·13 % of copper, 209·70 ounces of silver and 2·59 ounces of gold, per ton. If, therefore, the vein would yield an abundance of mineral of this same class, it would form a basis of an excellent negotiation.

We intend to explain the system followed in this country for the reduction of ores, when treating upon metallurgy in a chapter which will be devoted to that important industry, and to show the amount of copper which should be contained in regulus so as to suit the requirements of the market.

No doubt that if proper explorations were to be made in the mountains where this mineral occurs, other veins, equally, or probably richer in copper, silver and gold, would a discovered.

It is known that close to the mine,—minerals from which the assays in the last preceeding table refer—various other lodes exist which are vsible at the surface, and may be traced for some distance, and these contain mineral similar in quality to that last described.

At the surface, these veins present carbonates and oxides of copper, mixed in a base of quartz.

Various samples have been obtained from a mine called "*Avellaneda*", which yielded from 24 to 42·50 °/₀ of copper, with a small quantity of silver and traces of gold.

Doctor Kyle stated, that when he visited the district of *Calamuchita*, he saw various other mineral veins identical in character to the last preceding one which he described and a sample of 130 lbs. in weight obtained gave 46·6 °/₀ of copper, about 13 ounces of silver and 0·44 of an ounce of gold per ton. It would appear that this mineral was found somewhere in the neighbourhood of Rio Cuarto, and at a short distance from the railway. Doctor Kyle added that these circumstances present the advantages of being able to transport the mineral from the district he examined to the lower levels at a small cost and that the outcroppings of the mineral veins may be seen over a great extension, and lastly, that the veins in question are of great thickness, with a high percentage of copper, carrying gold and silver.

The largest sample of mineral obtained from this district, and assayed by Doctor Kyle, yielded at the rate of 13·4 ounces of silver and 2·67 ounces of gold per English ton.

Gold Mining District of San Ignacio

The ancient mines in this district are situated in the valley of *Punilla*, at a distance of about 12 leagues in a north-western direction from the city of Cordoba.

Various old workings exist in the mines, which, according to the best evidence were made by the Jesuits.

The auriferous veins run in the direction of north 40° east, and incline at a high angle, almost perpendicular.

The thickest of these veins varies from 60 centimetres to 3

metres, and the thinest had a width of 20 centimetres but was exceedingly rich in gold.

This thin vein of auriferous mineral is said to have disappeared at a distance of 250 metres upon the strike of the vein, but the late Mr. J. D. Loynachan, a practical American miner, examined these mines and presented to the writer a collection of rich auriferous ferruginous quartz samples, which he obtained from the mines in question. He reported that the old workings were in such a ruined condition that it was impossible to enter for any considerable distance, although the workings could be traced for a long distance upon the surface.

The writer commissioned one of the Engineers of his official staff to examine the mines of this province, and he reported that the ancient miners had worked upon the larger auriferous mineral vein for a distance of 350 metres.

Within the last few years, a small company undertook to re-open these gold mines, and for that purpose commenced an adit from the level of the valley upon the thinnest vein of mineral, with the object of reaching the larger vein. Three vertical pits had also been made upon this mineral guide, or thinest vein, but the Engineer could not descend either of them. They appeared to have a depth of 20 metres; but they had not been connected to the adit.

The Engineer referred to presented a sample of mineral which he obtained from these mines, which yielded by assay 80 grammes of gold per ton; but those presented by Mr. Loynachan yielded a larger quantity of gold per ton.

It appears that these mines were again abandoned, and that more recently they were obtained by Mr. D. Andres Baden, a Civil Engineer, who intended to re-open them, but what success he obtained is unknown to the writer.

In the same locality other auriferous veins of mineral exist, but no formal works have been placed upon them, so that

their productive qualities and commercial value is unknown.

Sometime prior to 1895, a company was formed to work some of the copper mines in this province, and for the reduction of the ore. A small fundition was installed at a place situated at a distance of about 3 miles to the south of the small village of *San Agustin,* and on the side of a stream of the same name.

In this establishment an Iron *Water Jacket* reduction furnace, 36 inches in diameter, was erected and there were other machines: the movement of the whole was obtained from water force, which was brought to the establisment from a distance of 600 metres.

A considerable amount of capital was expended in mining and smelting operations; but the results are unknown. However, for some reason or another, the workings were suspended.

Another company formed in, or about 1888, procured various concessions of mines, and commenced to exploit some gold mines. The mineral consisted of auriferous ferruginous quartz, and at, or near to the surface, the ore was very porous. Sometimes large cavities existed in the quartz which were lined with red oxide of iron, and in these a large amount of gold could be seen. Indeed, a selection from such cavities would have assayed from 2000 to 3000 ounces of gold per ton. At greater depth these appearances ceased, and the quartz was poorer in gold. After expending a considerable amount of capital, and working for some years, the affair was abandoned.

Mines of *Wolfram* are now being exploited in this province, and various isolated deposits of *mica* exist, but irregular in quality.

There also exists a great abundance of lime-stone, from which quick lime is made. Also an establishment has been erected for the production of carburide of calcium.

From the general sketch which we have been able to give of the mines of this province, it must be manifest that it contains an abundance of mineral wealth, and all that is required, is sufficient capital, economically applied, for the development of the mining and metallurgical industries. No doubt these might be created to great advantage to those who would care to adventure in them, but the examples of failure which has so frequently occurred from the application of inadequate capital, inept administration and mere speculation must be avoided, if success is to be attained in such undertakings.

CHAPTER XIV

Mines and Mining in the Province of Buenos Aires

This province is bounded in the north by the provinces of Cordoba, Santa Fe and Entre Rios; to the west by part of the province of Cordoba and the National Territories of the Pampa Central and Rio Negro; to the south and east by the Atlantic Ocean and Rio de la Plata.

This province extends over an area of 305,121 square kilometres, it is, therefore, the largest in the Republic; and, as an agricultural and stock breeding district, is exceedingly important and, consequently, no mining industry compared to the andine regions, is carried on in it. Nevertheless, an extensive exploitation of the granite quarries of Tandil, and other places, is effected, the stone being greatly employed for building and paving purposes.

Various mining and exploring concessions have been obtained from the provincial Government, ranging from 1874 to 1903. Some of the miners proposed working these. Others were denominated as mines of lime, petroleum, gold and silver, as also, salt; but there is no data to hand proving that any of these concessions were obtained for the purpose

of a formal exploitation, and if any attempts were made there are no returns as to the productive qualities of the mines under notice.

The South American Salt and Chemical Production Company (Limited)

Formerly a syndicate was formed for the object of obtaining from the Provincial Government of the Plata, a special concession for the exploitation of the Salt which was discovered in solution in one of the lakes situated partly in the *Rio Negro* district. After a great deal of delay, a permission was obtained, and possession of the salt mines—if the phrase is allowable—was granted. However, difficulties occurred upon a change of government in the province, and more delay occasioned; but, finally, the original claims of the company appear to have been recognised by the provincial Legislature.

A considerable amount of capital has been expended from time to time, but the original modes of exploitation did not seem to answer the objects of the company or market demands, consequently, a new company was formed, and additional capital obtained for the object of exploiting the salt according to modern systems.

The water in the lake is highly saturated with salt, derived, no doubt, from some deep seated beds of rock salt.

The plant now installed consists of a powerful pumping station to pump the saline water to a raised reservoir, from whence the brine is conveyed by means of 4 inch diameter iron pipes for a long distance to other works situated at the *Bay of San Blas*. These works consist of a receiver and evaporating basins, some of which are covered and others are in the open air, by which means, two classes of salt are obtained, one very fine and the second coarser.

The company has taken all possible means to ensure good results, and to maintain its produce without limit, and in this way an industry of great importance has been instituted in this province.

The salt has all the qualities necessary to recommed it for domestic and all other purposes.

It has been analyzed by various professional chemists. The following is by Doctor P. N. Arata.

Water per cent	0.95 °/₀	1·27 °/₀
Chloride of sodium.	97·49 "	96·68 "
Sulphate of calcium	0·51 "	0·77 "
Chloride of calcium	0·91 "	0·77 "
Chloride of magnesia.	traces	traces
Oxide of iron, silica, insoluble matter	traces	traces
	99·86	99·49

From this analysis, it is evident that the salt is of excellent quality and sufficiently pure for all branches of industry to which salt can be applied.

Another analysis of this salt was made to accompany a collection of samples of salt, in various forms, which the writer included in the collection of minerals which he exhibited in the Argentine mining and metallurgical section at the Chicago Exhibition in 1893.

Chloride of sodium	97·67 °/₀
Sulphate of sodium	traces
Sulphate of calcium	1·72 "
Chloride of magnesia	0·09 "
Insoluble matter	0·08 "
Water.	0·44 "
	100·00 °/₀

The mining and metallurgical section of this Republic and that of Spain, in the above named exhibition, were along side each other, and the technical commissioner of Spain frequently examined the salt in question, and as he was also a member of the Jury, it fell to his lot to examine the exhibit of salt of the Argentine section in a technical and critical manner, and he determined that the salt produced by the Rio Negro salt company, was of a superior class; and in his report to the whole body of commissioners of the jury of awards said that this salt "is the best for a commercial purpose, of any presented in the Exhibition", and on arriving at this conclussion, he made a comparison of the celebrated salt of Cadiz, large samples of which were exhibited in the Spanish section.

The general commission of jurymen, consequently, gave the company the highest award.

It is, therefore, useless to cite other favourable opinions, such, for example, as that of Don Manuel de la Fuente, President of the Union of proprietors of the company of sal of Cadiz.

The Rio Negro salt Company is believed to produce a large annual quantity of salt; but the writer possesses no data relative to the exact quantity.

CHAPTER XV

Mines and Mining in the National Territory of The Andes

This large and important tract of land is situated in the north-western part of the Republic, and is bounded to the north by Bolivia, to the east by the provinces of Salta and Jujuy, to the south by that of Catamarca, and to the west by the eastern limits of part of the Republic of Chile.

It is a new national territory which passed into the possession of the Argentine National Government by arbitration in 1889, and extends over an area of 64,500 square kilometres.

The small hamlet called *San Antonio de los Cobres*, has recently been created the capital of this territory, and is the official residence of the governor and his staff.

This region was originally claimed by Chile, as also by the provincial government of Salta. For a considerable time prior to 1899, extensive deposits of *Borate of lime* were known to exist in this territory, and, in one or two cases, the authority of Salta conceded a permit to exploit them.

The chilian authorities, also, knew that this tract of land, originally known to them under the name of *Puna de Ataca-*

ma, contained much mineral wealth and, therefore, there was much reluctance to give it up, but it must not be confounded with those extensive regions called the *Desert of Atacama*, which is situate on the western side of the divisory line between the two Republics and in which existed such immense camps of Nitrates and Guano-deposits.

To reach the central mining districts of the National Territory of the Andes; it is necessary to obtain mules und guides, and all provisions for the journey from Salta, which occupies days continual travelling and, with few exceptions, the mule tract passes through mountain regions devoid of resources.

The route passes through a serie of alternate gorges and over mountain ridges, each succeeding one rising higher than the preceding ones, so that the journey is not only fatiguing, but dangerous as well.

The *plateau* or table land of the Territory of the Andes at a place called Cauchari attains an elevation of at least 4000 metres above sea level, and constitutes an extensive undulating camp or desert, as far as the eye can reach, and is bounded to the west by chains of mountains rising one above another and extending into the main andine chain which separates the Argentine and Chilian Republics. The desert camp possesses no resources whatever, either for man or beast, and the few indians scattered about this enormous camp, and in the valleys surrounding it, are of the poorest class imaginable. Of the birds inhabiting these high regions only one or two types have been discovered, and these are mere starvelings. There is nothing to represent pasture except, here and there, a few withered tufts of hard grass.

It is a saline inhospitable region utterly incapable, in its present natural condition, to support such a population as may hereafter be required to exploit the mines already discovered, and hereafter to be discovered.

Consequent upon the accounts received from Chile and the province of Salta, referring to the large deposits of borate of lime, said to exist in these elevated regions, there was, to use a gold miners expression, *a great rush*, and the National Government offices of mines and geology received a large number of applications for borate concessions.

The principal districts in which the borate of lime deposits exist are; 1st., *Caurchari;* 2d., *Antuco;* 3d., *Pastos Grandes;* 4th., *Hombre Muerto;* 5th., *Ratones*, and 6th., *Diablillos. Ratones* has an elevation of about 3450 metres.

The first named is situated at a distance of 180 miles from the railway station at Salta, *Cerrillos*, the second at 144 miles, and the third at 189 miles respectively.

The altitude of these regions varies between those already assigned, the mule tracts leading to them passing over sterile plateaux, precipitous mountain ridges and gorges. Nevertheless, some years since a german, the late Mr. G. Boden, obtained concessions for the exploitation of certain borate deposits, and he exported several tons of mineral to Germany.

Besides this miner, it should be noted that another pioneer, Mr. Fressart, of French nationality, actually founded minerals in these regions employing as fundent borate of lime, and other elements.

The borate of lime deposits are irregular in thickness, and in some places the mineral is found at the surface; but, in general it is covered with debris of from a few inches up to 1 yard in thickness; the debris having to be removed before the borate of lime can be extracted.

In the whole of the mining districts of this Territory about 219 concessions of borate of lime have been applied for, and. of these, 20 have been granted and 199 awaiting to be granted, Also, 126 applications have been made for exploring rights.

Various questions of a legal nature have arisen in reference

to concessions on applications in general, affecting virtual or claimed rights, consequently, more time has been taken up in studying and deciding these questions than is ordinarily the case.

It appears that a strong English company, possesses extensive borate of lime deposits in various parts of the world, and that the agent or Engineer of that Company visited the borate deposits of the Andine territory. It also seems that offers were made with an object of acquiring the concessions which various persons had applied for to the National Government.

This exterior action on the part of the agent or Engineer referred to did not facilitate the official dispatch of the claims, but, on the contrary retarded them, because opinions were emitted, not favourable to some of the claimants for mining concessions; besides, plans exhibiting the limits of some of the mines, and calculations as to the quantity of borate of lime were made, which could never be officially received.

Various estimates have been made referring to the cost of transport of the crude borate of lime from the deposits situated in the districts named to the nearest railway station, and naturally a difference exists in such appreciations, caused, in some cases, by the facility or otherwise of obtaining a constant supply of pack-mules, and the exigencies and caprice of the mule owners, so that the cost of transport, by such means, must be uncertain and unreliable, unless, indeed, a contract could be made securing the mules at a determined price, and for a long period.

A mule load consists of 300 pounds and to transport an English ton 7·46 mules, or practically 8 would be required.

It is certain that if formal workings were to be established in the various mining districts of this territory, the cost of labour at the mines, materials and means of transport would be

augmented, because, when the difficulties came to be dealt with, the disposition of the miners employed would be uncertain, and there would be frequent changes and requirements presented by them: therefore, it is exceedingly difficult to settle, in an absolute manner, the cost of placing a ton of mineral at the nearest railway station—*Cerillos*—in the province of Salta.

However, taking all the conditions and circumstances into consideration, the writer believes that the following estimate of cost is as near an approximation to the truth as is possible, before a real exploitation has commenced.

Borate of lime differs in quality in the various districts, depending upon the quantity of foreign or brute materials mixed with it. In some localities it is however, comparatively pure, and samples obtained from the *Caurchari* deposits submitted to an official analysis, yielded the following elements.

Boric acid	39·50 °/₀
Hydrochloric acid.	0·46 "
Sulphuric »	0·26 "
Carbonic »	0·02 "
Carbon	7·38 "
Magnesia.	0·32 "
Lime	12·81 "
Oxide of Iron	0·39 "
Sand	5·08 "
Water.	33·78 "
	100·00

The borate of lime obtained from the Chilian deposits, is richer in boric acid than that contained in those to which we have been referring, and consequently, the type of 44 °/₀ has been accepted as a basis by which to estimate the *pro rata* difference in price to be paid for borate of lime having a less percentage of acid than 44 °/₀.

The price of borate of lime has fluctuated to a considerable extent in the London market during the last few years. For example, in March, 1899, the price was at the rate of £ 13 10$^{s.}$ 0$^{d.}$ per ton; but in the following month of April, the price fell to £ 11 10$^{s.}$ 0$^{d.}$.

In September, of the same year, borate of lime was offered at £ 10 0$^{s.}$ 0$^{d.}$, and in the following October, at £ 9 10$^{s.}$ 0$^{d.}$ It was understood that in 1900, one of the largest dealers in borate of lime actually made offers to sell at the rate of £ 6 per ton. Nevertheless, more recently a reaction set in and offers were made at £ 9 per ton.

It is, therefore, certain that due to the inevitable law of demand and supply, too frequently set in motion, *and controlled by curious modes of speculation,* the substance under consideration, like various other commercial articles, suffer violent fluctuations in market price.

Taking all the conditions and circumstances into careful consideration, it must be evident how impossible it would be to fix a definite price, beforehand, for this class of mineral. However, if an expert valuing engineer were to be consulted upon the value of any given district containing borate of lime, he would require to make an approximation to the truth.

In order, therefore, to make a fair estimate, which shall not savour of exaggeration, it has been taken that the average selling price of borate of lime, assaying 44 °/$_o$ of boric acid, would be, say, £ 9 per ton.

The various assays made of the borate of lime, extracted from the deposits of the Territory of the Andes, prove that it will not yield, as an average, more than 39·50 °/$_o$ of boric acid and, consequently, compared with the normal type of 44 °/$_o$, would suffer a *pro rata* reduction in the selling price.

The calculated reduction will, therefore, appear as follows.

As 44 per cent: 39·50 per cent :: £ 9, : the selling price delivered in England, per ton	£ 8 1s 9d
Total estimated cost of production	8 7 11
Loss per ton on sale. .	£ 0 6s 2d

The borate of lime deposits in the province of Jujuy, are situated at a place called *Tres Moros*, and the distance from the mines, to the capital, Jujuy, is 68 miles, and to the railway station of *Cerrillos*, in the province of Salta; by the way of the *Quebrada del Toro*, 112 miles.

By the first route, the transport is at the rate of 35 dollars per ton; but by the second, the cost of transport is 45 dollars per ton, an excess over the former of 10 dollars; but this is more than counterbalanced by the fact that by the latter route, the transport is more facile, and is effected, in part, by carts. The transport is, therefore, more rapid, and a greater quantity is transported in a given time, than when the mineral is carried entirely by pack mules.

The borate of lime deposits in the province of Jujuy, are exploited by a Belgian Company, and in order to make a fair comparison between the value of the mines here and those of the Andes, it would be fair to take the estimated working expenses at the same rate for both districts. The total cost, including working expenses and transport by the first route, in the province of Jujuy, would therefore amount to 62·10 paper dollars per ton, and by the second route, or that of the *Quebrada del Toro*, 72·10 dollars per ton. The *port* of delivery, in both cases, is that *of Colastine*.

According to these calculations, there exists a difference of 23·50 paper dollars in one case, and 13·50 in the other; per ton, in favour of working the borate mines of this province as compared with those in the National Territory of the Andes.

At *Tres Moros*, the locality in which the borate deposits are being exploited, no wood exists, consequently, it has to be carried from other parts of the province to the mines, where it is employed for the object of drying the borate mineral, and, for this object, drying furnaces or stoves with a large superficial area are employed. The mineral is thinly spread upon the heated surface of the calcining furnace, and frequently turned over, until a great part of the humidity has been expelled, after which the mineral is placed in bags for transport.

In Chile, the calcination furnaces are constructed with a heating surface of 8 square metres, of a form something like a reverbatory furnace, but with a level bottom upon which the borate mineral is spread to from 8 to 10 centimetres in thickness. A chimney is placed in the middle of the covering or arch of the calcining furnace to carry off the steam, and there is a stove at each end in which either coal or wood is consumed, the heat being distributed to all parts of the under-side of the bottom or platform, upon the surface of which, the mineral is placed.

Each furnace carries about 2 tons, and the whole of the drying, or calcining process, costs about 6 dollars per ton.

The form of the calcining furnaces employed in the province of Jujuy is not known to the writer, nor the cost of the operation, but it would not exceed that of Chile.

Upon the data which precedes, the following calculations have been made, and they are as near the truth as is possible under the circumstances. The two estimates of cost of transport have been employed.

	Per ton Dollars	Dollars	Per ton £ s. d.	£ s. d.
Cost of labour and wood in calcining the mineral....	6·00	6·00	0 10 4	0 10 4
Working expenses, transport, etc.....	62·10	72·10	5 6 2	6 3 4
Total cost on ship board at the port of Colastine....	$ 68·10	$ 78·10	£ 5 16 2	£ 6 13 8
However, the reduction of 33 % calcination affects the cosf of transport per ton of mineral in the same proportion, that is to say.....	$ 16·20	$ 19·30	£ 1 7 8	£ 1 13 4
Reduced cost per ton due to calcination.....	$ 51·90	$ 58·80	£ 4 8 10	£ 5 0 4

These values have been reduced to an english standard, taking the rate of exchange at 2·32 paper dollars as equal to 1 dollar gold, and allowing 5·04 gold dollars as the equivalent to the english sovereign.

It will be observed that, in a general way, the calcination process does not eliminate the whole of the moisture from the borate of lime; 3·78 per cent has therefore been reduced from the assay value.

For the total reduced cost, and profit per ton, we have the following results.

	s d	s d
Total amount of cost delivered on board in the port of Colastine.....	£ 4 8 10	£ 5 0 4
Cost of transporting 13·4 Cwt. of dry mineral to Liverpool.....	0 13 5	0 13 5
	£ 5 2 3	£ 5 13 9
Warehousing, commissions, insurance, etc.....	0 1 6	0 1 6
Total cost delivered in England.....	£ 5 3 9	£ 5 15 3

The difference shown in favour of drying the mineral, and the profit per ton, may easily be deduced, having the selling price of crude borate of lime in London.

However, the borate mineral existing in the various districts of the National Territory of the Andes, could not be treated in the same manner, because it would be necessary to transport the mineral for calcination purposes from remote places to lower levels in the province of Salta, or transport the wood to the mines.

Under these circumstances, it is difficult to understand upon

what grounds the London Consolidated Borax Company desired to acquire all the mining concessions situated in these elevated regions.

However, a company is about to be formed for the object of treating the borate of lime by a new process, which promises to yield beneficial results from the borate of lime deposits in the district of *Caurchari*. It is proposed to place an establishment in the mountain regions in a locality well adapted for the object indicated.

The borate of lime deposits in Peru and Bolivia, contain the following elements.

	Peru	Bolivia
Boric acid	45·90 %	38·74 %
Soda.	7·80 "	13·23 "
Lime.	4·80 "	13·83 "
Water	35·80 "	32·35 "
Potash	— "	0·68 "
Sand and earth. . . .	— "	0·96 "
Magnesia	— "	0.21 "

The quality of the Chilian borate of lime is too well known to be repeated; but as a comparison of cost and profit, it is considered advantageous to give the following estimates.

The principal supply of borate of lime in Chile, is obtained from three districts i. e., *Ascotan, Salinas Grandes* and *San Pedro de Atacama*. The first is situated in the neighbourhood of the volcan of the same name. The railway station at *Ascotan* appears to be situated in about 22° 27′ south latitude, and 68° 25 west longitude.

The writer has investigated this question as far as possible, and has ascertained that the borate of lime deposits at *Ascotan* are exploited by the London Consolidated Borax Company, which seem to have a branch railway from the mines of *Ascotan* to the Grand trunk railway running to Antofagasta.

It is reported that the cost of transporting the mineral is at the rate of 16 paper dollars, or say £ 1 7^{s} 4^{d} per ton, and if we add the cost of transporting the borate of lime from Antofagasta to England, or say at the rate of £ 2 per ton, we should have a total cost for the delivery of the mineral in England of £ 3 7^{s} 4^{d} per ton.

Estimated cost of working etc., say. . . .	£ 5	18^{s}	10^{d}
Warehousing, commissions, insurance, etc .	" 0	1	6
Total estimated cost .	£ 6	0	4

Exclusive of the cost of transporting the borate of lime by sea, we have taken the other calculation upon the produce of crude borate, or humid mineral, delivered near to the port of Antofagasta, where it is dried for transport.

We must, therefore, consider that instead of having to transport by sea to England 1 ton of crude humid ore, at the rate of £ 2 per ton, the drying process reduces it to 13·4 hundred weights, and, consequently, the entire cost would stand as follows:

Cost of transport at the rate of . . .	£ 1	6^{s}	10^{d}	per ton
Exploiting, drying, etc., etc.	" 2	11	5	" "
Carriage of mineral from the mines to Antofagasta	" 1	7	4	" "
Contingencies, insurance and commissions	" 0	1	6	" "
Total cost delivered in England .	£ 5	7	6	per ton

Although the estimated cost of production and preparing the mineral was taken upon the ton of crude mineral, the transport was taken upon the produce of a ton of mineral in its reduced or dry condition, and in order to make a fair comparison, instead of selling a ton in weight, we should only have 13·4 Cwts. to sell.

Now, if a ton of dry mineral containing 44 °/₀ of boric acid were to be offered at the rate of £ 6 per ton, as it has been reported, the 13·4 Cwts. would have a *pro ratia* value of £ 4 6ˢ 4ᵈ ½ i. e.

Cost of production and transportation of 13·4 Cwts. of mineral to England. . . .	£ 5	7ˢ	1ᵈ
Selling price of 13·4 Cwts. of dry mineral. .	" 4	6	4 ½
Loss upon the transaction. . .	£ 1	0	8 ½

To put the case in another form, a ton of dried mineral would be sold, say, at the proposed price of £ 6, and, consequently the transport from the port of embarcation to Europe would cost £ 2 per ton, as it would for a ton of humid mineral.

	Per ton		
Then the entire cost of production and transport would be equal to.	£ 6	0ˢ	3ᵈ
Proposed selling price	" 6	0	0
Estimated profit per ton . .	£ 0	0	3

We should get the same figures by adding the cost of transporting 6·6 Cwts. of dried mineral to the sum of £ 5 7ˢ 1ᵈ = £ 6 0ˢ 3ᵈ.

It is difficult to comprehend how a strong London Company could offer a large quantity of dried borate of lime, containing 44 °/₀ of boric acid at a profit of £ 0 0 3 per ton, unless, indeed, their working expenses were less than that estimated above, but it may also have been in excess.

At all events, we have proved that nothing is gained by the drying process, except the difference between the cost of transport of 1 ton of humid mineral, and its product in a dry state. The idea entertained by some that the percentage of the mineral is augmented by the drying process is absurd, for the

reason that the low degree of heat employed in calcining the mineral could not, by any means, concentrate the boric acid contained in the mineral; but it may have the effect of diminishing it.

We have already shown in this chapter, that as the borate of lime camps in the territory of the Andes, exist at such a long distance from any Railway station, and that at present there is no other mode of transport except that of pack-mules, and at such an exhorbitant cost, it would be utterly impossible to exploit the mines upon a large scale so as to obtain adequate profit, consequently, no large company in existence, possessing large experience in the cost of producing and selling borate of lime, could pretend to possess all the borate concessions solicited in the territory of the Andes with a view of exploiting them: we can only infer, therefore, that the intention is that of monopoly; but according to the dispositions of the code of mines of the Republic, the possessors of borate properties are obliged to keep constantly upon the ground 6 workmen for each concession during 230 days in each year, with the condition that on the contrary the property or properties are forfeited to the State.

Such an establishment as that proposed to be erected by an independent company, in a suitable place in the mountains, and employing a new process for the treatment of the mineral with a view of raising the percentage of boric acid by the expulsion of the greater part of the deleterious elements, must be encouraged, and the operations of the company facilitated by all possible means within legal and equitable limits.

All the elements necessary exist in the locality selected for the new establishment, and after having studied the new process, the writer is satisfied that sucess will attend the efforts of the projected company.

The demand for boric acid is increasing every year, and for

these reasons, commercial houses are exploring for new deposits of borate of lime, or such other substances as contain boric acid in sufficient quantities to produce a profit.

The deposits of hydro-borate of lime etc., in the United States of North America, Turkey, Peru, Bolivia, Italy and other places, are being exploited, and those of this Republic will follow.

A probable close approximation to the true yield of boric acid would be about 22,000 tons per annum.

It is an important commercial article and has a variety of uses, and in an article in the "Chemical News" by Mr. Fleming, 13th. February 1891. It is stated.

" Borax is now generally and extensively used amongst the " industries of the world and such advances have been made " during the last 30 years, both in new discoveries of the mi- " neral itself, or of material from which it can be manufactured, " that some account is rendered necessary of its consumption " and production. It is employed in various branches of " hardware, earthenware, textile, chemical and food industries. " In the capacity of a flux for the reduction of precious metals, " and in soldering gold, it is used for brazing copper, for " welding steel and iron together, for enamelling both copper " and iron, and for lining between the inner and outer shells " of fire proof safes.

" Mixed with other ingredients it forms a very fusible glass, " fit and necessary for glazing china, earthenware, bricks and " tiles. It is used in the manufacture of glass, and also in those " cements that take a polish after setting.

" It is employed in dissolving shellack, in the manufacture " of hats, in dissolving the glutinous matter adhering to raw " silk by weavers, in calico printing, and fire proofing delicate " fabrics, in the fabrication of paper, in starch, glazing linen, " and the preparation of candle wicks.

" It is used in dyeing leather, curing hides and skins, and the " chemical tanning of leather.

" In the chemical industries it is employed in the production " of borate of Chromium, borate of manganese, in the manufac- " ture of soap, in the formation of toning baths for silver prints. " by photographers, and in several pharmaceutical preparations,

" As a food preserver it is now largely used by American " pork packers as an antiseptic, many thousands of tons of " bacon being so preserved annually. "

No doubt other uses will occur, rendering the demand greater, and as some of the greater camps of borate of lime diminish in their productive capacity, the price of boric acid, and the crude mineral will rise. No doubt this is the reason why the largest companies are exerting all their energies to acquire as many deposits of this mineral as is possible, so as to be able to control the price at which this mineral shall be sold. In this way, if a company is strong, it could at times undersell others, at a loss, with the assurance that smaller companies, with limited resources, would fail; but in the end the larger ones would realize a fortune.

In order to direct attention to the discovery of substances containing boric-acid, the following will show some of the more important ores i. e., Axinite, boro-silicate of alumina; iron, etc., 2 to 5 °/₀; Boracite, borate of magnesia, 61 to 62 °/₀; Crytomorphite, hydrous borate of calcium and sodium, 5 °/₀; Datholite, boro-silicate of lime, 18 to 20 °/₀; Hydroboracite, borate of lime and magnesia, 41 to 48 °/₀; Lagonite, hydrous borate of iron, 48 °/₀; Lardevellite, hydrous borate of ammonia, 68 °/₀; Ludwigite, borate of iron and magnesia, 16 °/₀; Priceite, borate of lime, 49 to 50 °/₀; Rhodizite, lime boracite, 30 to 45 °/₀; Stassfurtite, boracite, 61 °/₀; Sussexite, hydrous borate of manganese and magnesium 32 °/₀; Szaibelyite, hydrous borate of magnesia, 37 °/₀; Tinkalzite, borate of lime,

37 °/₀; Tourmaline, boro-silicate of aluminum and magnesium, 2 to 8 °/₀; Tiza, boro-natro-calcite 30 to 40 °/₀; Ulexite, boro-natro-calcite, or hyrous borate of calcium and sodium (hayesine) 42 °/₀; and Warwickite, boro-titanate of iron and magnesium 27 °/₀.

Theoretical Considerations upon the Formation of Boric Acid

We are informed upon the authority of some of the most eminent chemical metallurgists of the day, that two forms of Boron have been already recognised, one as a greenish brown amorphous powder, slightly soluble in water, and the other (adamantine) crystalline, and with a lustre and hardness inferior only to that of the diamond. Boron does not, however, occur in nature in a free condition, but it may be prepared by treating boric acid at a high temperature, with some powerful reducing agent. For a further explanation, Watt's Chemical Dictionary may be consulted.

Sulphate of boron, may be said to be a white crystalline body, decomposed by water.

Amorphous boron, is a greenish-brown powder; it burns in oxygen, and gives off boric acid and, at a red heat, it decomposes water and forms the same acid and hydrogen.

Carbon boride, crystallized from fused copper, is a black crystalline substance, igniting when heated in oxygen at 1830° Fahr.; but it burns with difficulty because the boric anhydride produced, forms a protecting film. It is, however, insoluble in all acids, but is attacked by fused alkalies.

It is known from experience, that *Basalt* fuses at 2,250° Fahr. while *Rhyolite* is still viscid at 3,100 Fahr.

The lower temperature of volcanic effusions is characterized by steam, carbonic acid, etc.

Williams, in his "Manual of Lithology", states, that with the higher temperatures, both fluoric and boric acid are associated, and we are still further informed that the elements of water may be even retained in fused compounds, at the temperature of gnition under atmospheric pressure, as is seen in hydrates and acid sulphates of potassium; but, in certain vitrious borates of sodium and potassium, which at a red heat, and in tranquil fusion, hold an amount of hydrogen equal to 1·2 and 1·3 hundredths of water, and are, under these conditions slowly decomposed by metallic iron, with abundant disengagement of hydrogen gas, which burns with a green flame from the presence of combined boron. The best authority to consult upon such curious and important details is Prof. T. Stery Hunt in his "Mineral Physiology".

It is impossible to enumerate here the various theories which have been advanced, from time to time, with the view of explaining the origin and formation of boric acid, and of the mineral containing it; but the writer is of the opinion that the difficulties which surround this curious and interesting question, are almost insuperable, and have for the moment impeded a proper and definite solution.

The natural phenomena connected with the borax deposits of Italy, would seem to point to the true source from whence the boric acid emanated.

Under all the circumstances presented, it is highly probable that at undefined depths in the crust of the earth, rocks existed, and still exist, containing the elements of boric acid, and that these were acted upon by alkaline substances in a fused condition which, together with other elements, liberated boric acid, and this being mixed with hot humid sulphurous and other gases, ascended together through volcanic craters, cracks or fissures in the strata, and, finally coming in contact with cold air, became condensed and precipitated, and meeting

with other mineral elements, some probably in solution, such as carbonate of lime, would combine and form the mineral known as *Priceite*, and others, as also various other elements such as sodium chloride, as is seen by an inspection of the classifications already given.

When in solution, such mixed elements as those indicated, would flow or be carried to lower levels and become deposited in open fisures of the rocks, and, also, in basins or lakes, and, in some cases, veins of borate of lime, etc., would be formed and, in course of time, become solidifield and partially crystalized between the rocks.

No doubt a similar process must, in some cases, have taken place in other surface depressions, afterwards becoming lakes, and when the water evaporated, or the ground was raised or consolidated, a compact mass would remain, and afterwards become covered with surface soil.

It is, also, quite possible that in other cases, the deep seated gases ascended through fissures directly into basins full of water, as is the case in Italy and, apparently, in North America. No doubt the water in the lakes was highly charged with carbonate of lime and soda, which would at once unite with the boric acid gases and produce the mineral in the condition in which it is found. It is highly probable that the borate of lime deposits, etc., found in South America, Asia and the United States, were formed in some such manner.

The fact that boric acid is found in *Tourmaline*, which is crystalline silicate of alumina and magnesia, is a proof that this element exists in the rocks as previously demonstrated.

Referring to the technical modes of treating boric mineral, various systems have been proposed, such as those of Gootch, Rosenblatt, Moor and others. The latter obtained a British Patent in 1899, and his system seems to fulfil the required conditions.

The simple methods of using chlorine and sulphuric acid for the extraction of boric acid from boro-calcite and mud deposits are too well known to be described here.

The quantity of *sulphuric acid* required to extract the boric acid from a given weight of borate mineral depends upon the amount of calcite present, also, the quantity of *carbonate of soda* to be employed with the boric acid to constitute *borax*, depends upon the amount of lime present.

It may, however, be determined very exactly in the laboratory.

In some small establishments which existed in this country, the quantity of sulphuric acid employed in the process of refining the borate of lime, has been at the rate of 1 part of the former to 3 parts of the latter.

In the territory of the Andes, large deposits of sulphur exist which, later on, will, no doubt, be utilized for many purposes. It is of an excellent quality.

Copper mines also exist there, one of which was worked to a small extent some years since by Mr. Fressart, who founded the mineral in a rude furnace which he constructed, but copper mining and smelting operations were discontinued.

Gold mines also exist, one of which contains veins of auriferous quartz. Ancient workings and excavations have been discovered upon this quartz vein, which are believed to have been made by the Indians. The pits and excavations are now filled with debris and stones, the work of atmospheric action and time, or of the Indians.

Mr. Fressart made other pits close to the ancient ones, and discovered some of the copper tools employed by the Indians in their mining operations, so that the gold mines in question must have been exploited during the bronze age, probably before, or during the earlier Inca period.

Naturally, in a district so remote from the centres of civi-

lization, with but few natural resources, Mr. Fressart has exploited his gold mine under the greatest possible difficulty. The machinery he employs was made by himself, and is, naturally of a primitive kind just sufficient to enable him to pulverize the quartz and to treat it by the ordinary amalgamation process. The quartz is calcined and while in a hot condition is plunged into cold water, which has the effect of disentegrating it, and rendering it in a fitter condition for pulverization.

The pits made upon this auriferous vein of quartz, have a depth of 18 metres, and the amount of gold extracted is at the rate of 30 grammes per ton. Some portions of the vein have yielded at the rate of 45 grammes of gold per ton. Mr. Fressart has exploited this mine for a period of 8 years, and it is situated at an altitude of 4·600 metres above sea level. The owner has the intention of searching for aid, and introducing modern machinery to treat the mineral, but such machinery would have to be constructed in sections, each of which must not weigh more than 300 pounds.

No doubt the mountains surrounding the borax and saline camps, especially towards the west and north west, contain a vast amount of economic mineral deposits particularly copper veins which probably contain gold and silver, as also, many auriferous quartz veins.

These regions have not, however, been yet examined by practical mining experts, consequently, it is impossible to do more at present than speak in general terms.

The number of applications for concessions of mines and permits of exploration of mineral lands received in the Mining Offices of the National Government, have already been given.

CHAPTER XVI

Mines and Mining in the National Territory of Misiones

Not long since a large portion of this territory was transferred to the Brazilian Republic by act of arbitration dictated by the President of the United States of North America.

It is situated at the extreme north-eastern part of the Republic, and may be considered to be a continuation of the north eastern portion of the province of Corrientes.

According to the act of Arbitration, the north-western boundary of Misiones, is a branch or continuation of the river *Parana,* until it reaches the river *Guazu,* which, with the river *San Antonio*, bounds its northern and eastern limits. Its southern and western limits are bounded by the river *San Javier*. It extends over an area of 29,229 square kilometres.

In Chapter I, of notes upon ancient mines, etc., we have referred to this noted and historical tract of land, and given at length all that can be collected as to the mining feats of the Jesuits.

Various, so called, expeditions and commissions have been formed to examine and report upon the resources of this part

of the Republic; but as far as a mining region is concerned, nothing definite was arrived at. It is true that some stones were collected which appeared to be of a volcanic origin.

Nevertheless, there exist small deposits of native copper, various samples of which are in the possession of the writer: these occur in isolated places, as also, in thin veins about 2 inches thick, but they cannot be traced for any great distance due, probably, to the exhuberant vegetation. At all events, if they were to extend, no benefit would be obtained from an exploitation because a tunnel would have to be driven into the solid rock in order to extract the thin veins of native copper: besides, at present, it is a region but little inhabited, with indifferent resources and means of transport.

The writer has always held a firm opinion that the Jesuits possessed important gold and silver mines on the Brazilian side of the mountains which separate that Republic from Misiones, before the land was divided.

In fact it is a fine field in which explorations may be made with the probability that some rich mines would be discovered.

Various persons, from time to time, have applied forconcessions of native copper, and, also, for right of exploration, but although seven such applications are registered on the books of our mining offices, still, the requirements of the law were not carried out in either case, consequently the applications have lapsed.

In answer to a circular note from the National offices of mines, the governor of the Territory informed the writer that no mining operations were being carried on in this national territory.

CHAPTER XVII

Mines and Mining in the National Territory of The Pampa Central

This National Territory is bounded to the north by the provinces of Mendoza and Cordoba, to the east by the province of Buenos Aires, to the south by the river Colorado, and to the west by part of the National Territory of Neuquen, and extends over an area of 145,907 square kilometres. The Capital of the Territory is General Acha.

In searching for the old copper and gold mines of *Payen*, to which reference has already been made, a chilian mining pioneer, the late Thomas Bobadilla, imagined that he had traced *Payen* to this locality, and consequently, after having discovered some poor copper deposits, made application, in 1888, to the National Department of Mines and Geology for concessions of mines in the district of *Lihuelcalel*, naming his mining claims "*Descubridora*", and "*Elvira*". Soon afterwards, another chilian applied for various other concessions in his own name and in the names of others. There were as many as 52 solicitudes for mines, a selected group of which was granted. A company was formed in Buenos Aires to

exploit these copper mines. One of the principal subscribers, was Mr. A. Millot, of French origen, who for straightforward and honourable dealing, few could equal him. It was represented that the mines were rich in copper as, also, in gold and silver, and a diligent selection of a few small, but rich samples induced the shareholders to believe in the representations. Attempts at exploitation were carried on for a considerable length of time and meanwhile the writer procured a large number of samples from the various mines which were assayed; but the results obtained did not induce him to believe that the *Lihuelcalel* copper mines were equal to many others which existed in various parts of the Republic.

The writer commissioned one of the Departmental mining engineers to *demark* or set out the the mining concessions in question, make a map of the district and report upon the mines. This he did, and his conclusions confirmed the opinion which the writer had already formed. In his report, the engineer above referred to, Mr. Andres Franchy says "The quartziferous mineral existing in this district appears at the surface in various places and principally consists of Silicate of Copper and Oligistic iron, also, although in less quantity, *Erubescite*, oxide and sulphide of copper, which, in the samples assayed, have shown gold and silver, as may be seen further on.

The silicate of copper is found disseminated in all parts of the rocks in the form of impregnations and incrustations, as also minute veins of pure mineral.

The existence of copper, in the form indicated, is evident in the excavations made in the mines "*Flor de la Pampa*", "*Descubridora*", "*Dos Chilenos*", "*Elisa*", "*Elvira*", etc., and extends for a distance of 2 kilometres.

The mine "*Flor de la Pampa*", contains a mineral vein 25 centimetres in thickness, running north 20° east, and inclining 83° towards the west. It is composed of silicate of copper and oligistic iron.

Of the distinct geological phenomena observed in this district, and the study of the various samples of mineral, the following theory referring to the origen of the silicate of copper in the *Lihuelcalel* district has been deduced. Originally, it is highly probable that the copper existed in the form of pyrites, which by the decomposition of its superficial parts, must have been oxidized and become converted into soluble sulphate, dissolved by water and attacked by calcium silicates contained in the felspar of the adjoining rock, and converted into silicate of copper, which was finally deposited as incrustations and impregnations in the form in which it now occurs.

This theory, which is the one which accords more with the different things observed in this neighbourhood, induces the inference that in the depth sulphides of copper may exist".

The following assays of mineral from this district were made in the laboratory of the National Department of Mines and Geology.

NAME OF MINE	Copper per cent.	Silver per French Ton.
"Flor de la Pampa".	7·25	95 grammes
"Elisa"	3·92	15 "
"Descubridora"	4·12	74 "
"Elvira"	5·40	25 "
"Dos Chilenos"	7·40	10 "
"Elvira" (Quartz).	0·00	75 "

A more complete assay, made of some selected samples from the mine Elisa, which presented small points of auriferous pyrites and sulphide of copper, gave the following result.

Copper . . .	36·33	%
Silver	102·06	grammes per ton
Gold	10·00	

If, therefore, solid copper lodes of a fair thickness existed, from which a large annual yield could be obtained, the last preceding analysis would be all that could be required for a beneficial exploitation; but the engineer referred to does not indicate any such conditions in his report. However, the theory he has proposed led him to form the opinion that such conditions may exist in the depth. It is only, therefore, a question of a practical trial.

Without a personal study upon the ground itself, the writer cannot prove, or disprove, the conclussions arrived at by the engineer previously referred to.

Recently a new company has solicited some of the mines in this district, which have been granted, so that if works are extended in them, the problem will then be solved, as also, their commercial value.

CHAPTER XVIII

Mines and Mining in the National Territory of Neuquen

This exceedingly important tract of land is bounded to the north by the southern extremity of the province of Mendoza; to the east by a portion of the Territory of Rio Negro; to the south east and south, by the great river Limay and a smaller rivulet leading into it from the Lake Traful, and, from this lake to the west, by another small stream leading into it, and to the west, by the line of the great Cordillera, separating this national territory from a part of the Republic of Chile.

This tract of land extends over an area of 109,703 square kilometres.

Its close proximity to Chile, induced chilian mining adventurers and others to visit it, and they circulated various reports referring to the existence of rich auriferous deposits, which led to clandestine mining, but it is not known how long this part of the Republic was subjected to these incursions, or how much gold was extracted and taken to Chile. However, this occurred before the tract of land was constituted a National Territory, but has continued, more or less, since it was legally occupied by Argentine authorities.

Various voyagers, for they could not be denominated explorers, and engineers have visited this territory on various occasions; but their investigations, had no permanent beneficial result. In more recent years, Messrs. Gilderdale and Hall explored the auriferous lands of *Mayal Mahuida*, and they considered that the gold existed in a sufficient quantity to pay for a formal exploitation and, consequently, applications were made to the then National Department of Mines and Geology for concessions of mines and, after due investigations had been made, the writer ordered the concessions to be made according to the regulations of the Mining Code of laws.

The Mayal Mahuida mining company was then established, and an Engineer was obtained from London to examine and report upon the gold mines, which be did in a favourable manner.

These gold mines were demarked and possession given by one of the departmental Engineers, Mr. Fabrega Cuello, in 1891.

The administration and management of the gold mines fell into the hands of an English manager, but the plan of mining adopted was inadequate.

The usual practice of seeking a low level place from which a drainage channel could have been made and continued to the bed-rock to drain off the water, and give other facilities for working, was neglected, and the curious and impracticable mode of making isolated excavations in the auriferous camp, n which water and large boulders existed, impeded proper mining operations, was adopted. The result was that the company abandoned the mines because, under bad management, they could not be made to yield any profit. One of the shareholders, Mr. Hall, a North American mining pioneer, seemed to have resided in this part of Neuquen, and when the company collapsed, he continued to work some of the

more accessible auriferous deposits, and procured a living until he was murdered by a band of ruffian some two years since.

The first mine registered in the books of the National Offices of mines and geology was that solicited by Don Tomas Bobadilla in 1886, for copper and silver mineral said to exist in a place called *Sierra Esmeralda.*

Deposits of coal are known to exist in various parts of the territory, and some of these have attracted much attention. Various Engineers have examined them with a view of determining the commercial value of the coal: but the opinions are very conflicting in regard to the quantity which may be obtained.

The coal is, however, of an excellent quality, as may be seen from the following analysis.

	N.° 1	N.° 2
Fixed carbon	53·90 °/₀	50·18 °/₀
Volatile matter. . . .	33·50 "	35·42 "
Ash.	3·55 "	10·65 "
Water	9·05 "	3·75 "
Sulphur	traces "	traces
	100·00	100·00
Coke	57·48 °/₀	61·13 °/₀
Contained ash. . . .	6·26 "	17·30 "
Calorific force. . . .	4·570	4·636

The above analysis were made by Doctor J. J. Kyle, and he also discovered that the ash contained *vanadic acid;* but not in such a large quantity as that found in the coal of *San Rafael* (province of Mendoza).

The Neuquen coal contains, according to a determination of Doctor Kyle, 3·5 °/₀ of *vanadic acid.* The average percentage

of the ash, as determined in the above analysis is 6·17; and the weight of acid, taken at the average per cent, would amount to 5·30 pounds; and this calculated according to the market value would, therefore, give a value of £ 4. 12. 9. for the acid contained in the ash.

The writer exhibited large samples of this coal at the Exhibition of Chicago in 1893, and the expert member of the jury of awards named to examine them considered that the coal possessed great commercial value, not only for its quality and general use, but, also, for the vanadic acid which it contained and, consequently, recommended that a premium should be granted for the coal.

A premium of the highest grade was also awarded to Doctor Kyle for his important scientific discovery in reference to the vanadic acid.

In the general official collections of minerals which the writer made for the San Louis Exhibition, large samples of the same coal have been included.

Various petitions have been made from time to time for coal concessions in Neuquen; but hitherto no formal exploitation has been entered upon. This is much to be regretted, for, although it may not be transported to Buenos Aires to compete with foreign coal, still it could be exploited and used in establishments of fundition for the reduction of copper and other minerals existing in this territory.

We shall again have occasion to refer to this subject in the special chapter which we propose to write upon the general coal question of this Republic.

Various galena veins have been discovered in the district called *Campana Mahuida* and concessions for the exploitation of these argentiferous lead veins were obtained by Messrs. Schmidt and Company. The Departamental Engineer set out the limits of 7 mines, and gave possession of them in August 1891.

The particulars of the galena mines are as follows.

Number of mines	Thickness of the richest part of the mineral veins in metres	Total thickness of the mineral veins in metres	Magnetic direction of veins	Inclination of veins	Lead %	Silver %
1	0·20 to 0·15	0·40 to 1·20	N. 10° W.	85° South	65	7·75
2	0·02 " 0·05	0·70 " 0·80	" 8· "	84 "	60	2·62
3	0·15 " 0·09	0·55 " 0·80	" 13·23 "	82 North	62	3·22
4	0·10 " 0·45	0·95 " 1·25	" 13·23 "	78 South	45	3·29
5	0·10 " 0·35	0·30 " 0·50	" 7·10 "	80 North	67	1·22
6	0·01 " 0·03	0·80 " 1·00	" 7·0 "	78 "	30	2·84
7	0·15 " 0·25	0·80 " 1·00	" 17·0 "	78 "	20	1·86
8	0·20 " 0·30	0·45 " 0·50	S. 3·15 "	60 "	70	6·03
9	0·06 " 0·15	0·30 " 0·45	" 14·0 "	76 "	80	0·38

It will be observed that the lead ore contains a large quantity of silver, and if it were distributed equally through the galena veins, and all the other conditions were favourable, a benefit should have been obtained from a proper exploitation of the mines and reduction of the mineral in furnaces of modern style.

These mines are situated at about 3 days journey from Chile, consequently, a ready market could have been found for the produce. Messrs. Schmidt and Company worked these mines for a considerable time with the intention of exporting the crude mineral, but this plan of working produced no benefit.

The company still hold possession of the mines.

Various petitions for copper concessions have been received in the National Government Offices of Mines and Geology, but, although the assays show that the yield of copper is sufficiently high to justify an energetic exploitation, still, for some reason or another, the legal processes for obtaining concessions were not carried out. Mines of silver also exist in this region.

There have been received no less than 211 petitions for gold mines, and of these 16 have been granted and legal possession given.

Recently a Chilian Company was formed to procure concessions of gold mines for the apparent object of exploiting them, but it is not known to what extent workings have been placed in them.

No less than 40 applications for coal mines have been made some of which have been favourably considered, and are now being demarked; but whether they will be exploited in a proper manner and upon a large scale cannot be stated.

Application has been made for 2 mines of rock salt and 6 for petroleum concessions. The last named have been granted and are now being demarked.

A railway has been projected to pass through this remote territory, and no doubt this has incited interested parties to search for and obtain concessions of mines.

The National Government Office of Mines and Geology has received no less than 392 mining applications, 112 of which were for permission to explore defined mining localities, and the rest for concessions of mines. Of the latter 25 have been granted.

When proper communication has been made to this territory, and a better system of transport provided, no doubt the mineral riches which have been proved to exist, will be developed in no small degree.

The writer, therefore, believes that this tertitory will have a great mining future. The attention of capitalists and other parties interested in discovering a legitimate field for the expenditure of capital, should be directed to this very rich National Territory.

CHAPTER XIX

Mines and Mining in the National Territory of Rio Negro

This large tract of land is situated between the National territories of Pampa Central, Neuquen, and the northern part of that of Chubut. Part of its eastern limits abuts against the southern part of the province of Buenos Aires, to the promontory of Main, on the Atlantic coast, and then follows the coast line to the eastern extremity of the northern boundary line of the National territory of Chubut.

The western part of the National Territory of Rio Negro projects westward to the line dividing it from part of the Republic of Chile. The part to the west of the 71st. degree of longitude is mountainous consisting of broken ground. In the middle part of the western projection of land, is situated the beautiful lake *Nahuel Huapi* which extends in length for a distance of at least, 10 leagues.

To the east of the degrees of longitude indicated, various isolated mountains exist which are very interesting from a mining point of view.

The lake mentioned may be more properly considered as

an inland sea, and the scenery surrounding it is the most beautiful to be found in the world.

The importance of this district has been graphically described by Doctor Federico Cibils, the Director General of the Department of National Industries.

The Rio Negro Territory extends over an area of 196,695 square kilometres, and is exceedingly important, possessing, as it does, two of the largest rivers in the Republic i. e., the Limay between it and the National territory of Neuquen, as far as its junction with the river Colorado, situated a little to the east of the 68th. degree of longitude, at which point the other i. e., Rio Negro commences and passes through this territory to the eastern coast at point Main.

This territory has not been scientifically and practically examined for minerals, and the few persons who have attempted it, could not devote sufficient time or elements for such objects.

Doctor Francisco P. Moreno, however, did more than any other person to make known the importance of this territory as is proved by his valuable publications.

No doubt the mountain regions of this territory are rich in mineral deposits, in fact we have examined large samples of pyrites of copper, and galena, obtained from the lake Nahuel Huapi, which contained a high percentage of metal.

In all the valleys existing between the mountains, and in the various streams, gold has been discovered and there are places surrounding ohe Lake *Nahuel Huapi,* where it has been discovered in considerable quantities.

A few days since, a gentleman exhibited to the writer several ounces of gold which came from this neighbourhood; but no formal exploitation or explorations had been made.

Doubtless, it is one of the most interesting and important districts in the Republic, and if properly organised explorations

were to be carried out in the mountain regions, west of the 68th. degree of longitude, no doubt many mines of various kinds would be discovered.

We are already aware that coal, salt, iron and marble, as, also, copper, galena, and gold have been discovered, but in the remote regions where the greatest abundance of mineral may be expected to exist, there does not exist quick and cheap modes of transport, consequently the same amount of attention has not been given to these regions as to others of the Republic.

The National Government Office of Mines has received 35 petitions for concessions of salt, coal, iron and limestone. For the exploitation of the latter a small establishment has been erected.

When, however, the projected railway, southwards, is completed, mining will undoubtedly have a very different aspect in this territory.

CHAPTER XX

Mines and Mining in the National Territory of Chubut

This territory is bounded to the north by the southern limits of the territory of Rio Negro; to the south by the northern boundary line of the national territory of Santa Cruz; to the west by the line dividing it from the Chilian Republic, and to the east by the Atlantic Ocean. It extends over an area of 242,039 square kilometres.

Series of low mountains are dotted over a considerable part of this territory, between which there are extensive plains or camps. These mountain ranges have never been visited officially, consequently it is impossible to say what mineral riches may be inclosed in them.

However, in several of these, auriferous quartz veins occur, and these have been tested upon a small scale.

For many years past, auriferous sands have been worked and a certain produce of gold reported. One or two of the former governors of the territory made some explorations into the interior, and their indications, especially those of Colonel Fontana, led to some practical experiments.

Two or three expeditions were made by the Welsh colonists

to a place far in the interior and upon rivers which they denominated Teca, Corcovado, Sagmata, Corrintos and others, and mining was carried on to a sufficient extent to prove that their rights should be protected as first legal discoverers. Delegates were, therefore, sent to Buenos Aires and their applications, after study, were finally granted and the mines demarked by one of the Departmental Engineers in 1893, who presented plans and a techincal report in which every particular was detailed.

A large number of samples were extracted from the different auriferous mines demarked, and these samples were assayed in a very careful manner, with a view of determining, as close as possible, the value and productive qualities of the mines.

An average of the whole of these assays gave 3·75 ounces of gold to every 72 cubic metres, or at the rate of 0·0534 of an ounce per cubic metre.

Considering, however, that the samples extracted were comparatively small, and obtained by the most primitive methods it is highly probable that if the auriferous sand had been treated by a good modern system and upon a large scale, a much larger produce per cubic metre would have resulted.

In the Teca district, there were granted 75 concessions of auriferous mines, and in the Corcovado river 55, all of which were demarked.

The Chubut miners, holding the mining concessions in the Teca district, commissioned a deligate to proceed to London to negociate with a syndicate for the exploitation of the mines, and a small syndicate was formed with a moderate capital to investigate the value of the properties before establishing a strong company.

Some time elapsed before the London syndicate had arranged to send out a mining expert and after his arrival, it was

found that the winter season and a heavy fall of snow, prevented him from carrying out any practical explorations, such as were necessary to determine the commercial value of the properties belonging to the syndicate, and, under such circumstances, it is impossible to conceive what the nature of his report could be.

By this time it would appear that the small resources provided by the syndicate for the use of the London offices and the intended exploration were exhausted, and the Directors becoming discouraged the whole affair was abandoned and the Chubut miners rights lost, the auriferous lands returning to the state.

The River Corrintos Gold Mining Company

This company was formed in 1894 by Mr. A. K. Von Heyking, for the object of purchasing and exploiting 14 auriferous sand deposits. The capital subscribed amounted to 75,000 gold dollars.

As the rio Corrintos has a sufficient fall and velocity, it was intended to introduce the hydraulic system, and as the yield was determined to be at the rate of 25 gold cents per cubic metre, it was believed that a good benefit would accrue to the company.

In order to carry on a system of mining in a proper manner, an expert hydraulic miner was engaged in the United States of North America, and to this miner, together with an administrator, was confided the management of the concern.

Mr. Heyking, the principal shareholder and Director of the company, informed the writer that the American expert by his curious manner of proceedings soon involved the company in difficulties and these were augmented by the death of the ad-

ministrator and confidential agent at the mines. Soon after this sad occurrence, two of the Directors and an expert mining Engineer visited the gold placers and determined that the properties extended over an area of 4,400,000 square metres, containing 100,000,000 cubic metres of alluvial ground, capable of yielding sufficient gold to justify a good exploitation.

Upon the report of the Directors and Expert Engineer, the capital of the company was augmented to 150,000 dollars gold, but it seems that the company became involved in a manner, which appears, according to the statement of Mr. Heyking, to have brought about its dissolution and, consequently, the mines were abandoned.

From all the information which can be gleaned upon this subject, it appears that the mines under discussion would yield a sufficient profit supposing that a good hydraulic system of mining were to be introduced with sufficient capital to install the works and for a three months development. At the end of that period it is estimated that sufficient gold would be extracted to continue the works, but all this implies good and honourable administration, without which, no mining scheme can succeed, no matter how rich the mines may be.

It is known to expert mining men, that, in auriferous deposits such as those we have described, the principal part of the gold is deposited upon the bed rock, in the crevices and hollows, but in the explorations undertaken the bed rock was not reached; consequently, the yield of gold per cubic metre would in all probability be much greater than that which was estimated on a surface trial of the superficial workings.

The engineer of the Department of mines sent to demark these mines, presented various samples of mineral which he extracted from veins in the higher parts of the districts, and an analysis of some of these gave the following result.

Copper.	25·50000 °/₀
Gold	0·00100 "
Silver	0·00074 "

In the report presented, no mention was made of the thickness of the mineral veins; but there is the following statement.

"In the mine "*Ess Mostyn*". I found that the quartz vein was impregnated with silicate and carbonate of copper, and a sample taken by myself gave the results above cited."

The yield of gold would appear to be at the rate of 0·35 of an ounce per ton. If, therefore, an abundance of ore of this quality existed, and all the surrounding circumstances were favourable, a profit would result from an exploitation if carried on upon a large scale.

The Direction of the then Department of Mines and Geology received solicitudes for the following mines and permits of exploration.

	Solicitudes	Concessions granted
	—	—
Salt	59	11
Gold.	163	157
Galena	13	—
State Quarries. .	11	—
Explorations . .	186	—
	432	168

Recently, a syndicate has been formed to obtain the concessions of the gold mines existing in this territory, and it is to be hoped that on this occasion the workings will be carried on in a more practical manner, so that benefit may be realized from the capital to be invested in this mining undertaking.

The Salt Company of Peninsula Valdez

This peninsula is situated on the Atlantic coast and is joined to the main land by a narrow neck of land which lies between the *Puerto San José* and *Golfo Nuevo*.

Two saline lakes were known to exist in this locality for a long time past, and these have been divided into various concessions which have recently been acquired by Mr. Piaggio.

The water of the lakes is highly charged with salt, and in the dry season the evaporation of the water near to the margin of the lakes, leaves a large quantity of salt of excellent quality.

A railway has been constructed from the coast to the lakes in question and active workings are being carried on.

CHAPTER XXI

Mines and Mining in the National Territory of Santa Cruz

This tract of land is situated between the southern boundary of the National Territory of Chubut, and the northern limits of Tierra del Fuego: to the west the Republic of Chile: its eastern limits being defined by the Atlantic Ocean. It extends over an area of 282,750 square kilometres.

It cannot be considered a very mountainous territory like some of those situated further north—Neuquen, for example—still there are a series of low mountain ranges distributed in an isolated manner.

A geographical description of this territory, as also of the whole of the Republic, is to be found in the excellent works of Doctor Latzina, Director General of the National Statistic Department.

Two great rivers pass through the territory and various lakes exist in it.

The mountain regions have never been properly explored and, consequently, the mineral wealth contained in them is unknown. However, various samples of copper and other

minerals have been presented to the writer, from which one may infer that important veins of copper ore exist in this territory.

Many samples of coal have also been presented from time to time, but these evidently did not belong to the great carboniferous period. Many of the samples could only be classed as lignite and bituminous schist.

However, it is likely that in this region coal deposits of a more recent formation may be found, and studies should be conducted there under the orders and directions of a competent mining engineer of great experience.

Gold mining commenced along the coast, and in the small streams coming from the Andes, as early as 1867, and in 1885, public attention was directed to the auriferous sand deposits along the coast, which were reported to be of great importance. A certain government engineer, of that period, praised up these auriferous deposits to the skies, and several important persons of Buenos Aires formed a company for the exploitation of *El Dorado;* but the mining operations only ended in the expenditure of the capital. Since that period, several persons have carried on mining operations, at intervals, upon a small scale up to the present time.

The gold is found in the black sand which is left upon the beach after the retiring of the waves and, consequently, is of constant occurrence.

The writer has not sufficient time at his disposal to enter into a lengthened history of these gold washings, but a complete history of them will be found in his larger works published in French and Spanish in 1889.

The concessions asked for and registered in the books of the National offices of mines and Geology, are as follows.

	Applications	Concessions granted
	—	—
Gold mines	11	6
Salt.	20	14
Coal	1	—
Explorations.	4	—
	36	20

The principal gold washings are situated in the neighbourhood of Cape Virgins.

The mines of salt are considered to be of great commercial importance and the owners Messrs Parmegiani and Company intend to exploit them on a large scale.

CHAPTER XXII

Mines and Mining in the National Territory of Tierra del Fuego

This tract of land forms the southern extremity of the Republic, and its western boundary is determined by a line commencing at a point on the southern side of the straits of Magellan, called *Espíritu Santo*, and then runs directly west to a point on the northern branch of the Beagle Channel.

Its southern limits are determined by the northern coast line of the Beagle Channel and the coast line of the southern ocean which surrounds its eastern and north-eastern parts up to the Cape of *Espíritu Santo*.

It extends over an area of 21,499 square kilometres, and is, therefore, the smallest of the National Territories, due to a claim set up by Chile, to which Republic the Argentine Government ceded a large part of the territory.

This National territory has not been explored in all its parts, so that it is impossible to determine, at present, whether it contains much mineral riches or not. However, the writer has examined various samples of minerals obtained from the interior.

Gold washings were carried on at various points along the coast of Tierra del Fuego previous to 1880, but these operations were effected in a clandestine manner, until the late, much to be lamented Don Julio Popper, a Rumanian Engineer, made a practical exploration in this region of wind and tempests. He satisfied himself that gold exist in sufficient quantity to permit of the expenditure of a modest capital, and upon his report a capital was formed in Buenos Aires. A considerable quantity of gold was extracted, and a bar of 11 kilos was exhibited by the writer at the Paris Exhibition in 1889.

For some reasons, not explained, this company ceased to exist, and Mr. Popper took over the mines and establishmen on his own account continuing the exploitation until 1893, when he suddenly died in Buenos Aires.

During the time he was occupied in mining operations, he is said to have experienced a great deal of annoyance from the then governors of the territory, although they had no legal authority to interfere in mining matters.

Since the death of this worthy scientific and learned practical mining pioneer, the gold washings have passed into other hands, and only a few miners are now scattered about washing the black sand thrown upon the coast after each tempest.

When the mining Engineer of the National Government Office of Mines was commissioned to visit the Bay of Sloggett, for the purpose of determining if a reported deposit of coal had real commercial value, he found 25 men employed in extracting the gold from the iron sand deposits.

These men, however, did not possess any legals rights, but had taken advantage of a certain prevision of the mining code which authorizes the exploitation of such gold deposits.

In chapter XIII of the large work of the writer, published in 1889, a complete history is given of the places where gold has

been found on the coast of this territory, as also a long discussion upon the probable source of the gold and other geological and philosoph cal questions of great interest, to which publication the reader is referred.

Some few years since, a North American endeavourred to dredge the sands supposed to contain gold, but he was obliged to give up the undertaking on account of the furious seas.

There exist upon the mining register of the Offices of Mines the following concessions and permits for explorations:

	Concessions solicited	Concessions granted
Gold	82	16
Coal	12	12
Petroleum	1	—
Peat	1	—
Manganese	8	—
Explorations	44	—
Mineral water	1	—
	149	28

Sixteen of the gold concessions have been taken up on the coast of *San Sebastian*, where there is supposed to be a fixed establishment for the extraction of the gold.

When we treat of the geology of the Republic in a separate chapter, we shall refer in a particular manner to the subject of gold deposits and their causes, as well as the places where old river beds containing the gold may probably be found.

For a long time past, it was known that lignite existed along the coast of this territory and it was strongly represented to the National Government that this locality offerred every facility for the extraction of a large quantity of coal for the Argentine Navy in case of emergency. It was, therefore, considered necessary to determine this question, and, consequently, the first

Engineer of the Department of Mines and Geology, Mr. Carlos A. Lynes Hoskold, was commissioned by the then Minister of War, General Levalle, in 1898, to proceed to the Sloggett Bay, situated on the southern coast of Tierra del Fuego, to make a scientific study and report upon the coal deposits, but he only found several thin veins with large pieces of carbonized trees, but no valuable deposit existed.

Three years previous, or in 1893, the writer exhibited some of the purest samples of the carbonized trees at the Chicago exhibition, with an analysis made by Doctor Kyle, which was as follows:

Fixed carbon	42·44 °/₀
Volatile matter	40·72
Ash	0·84
Water	16·00
	100·00

The member of the Jury, a commissioner for the Republic of Venezuela, was appointed to examine the samples alluded to, and he stated that he had never examined samples of lignite so pure. These samples were however obtained by the then Governor of the territory of Tierra del Fuego, from some other deposit along the coast but not from Sloggett Bay.

Mr. C. Hoskold, before referred to, informed the government that the lignite of Sloggett Bay possessed no value for the purpose intended. Afterwards, however, several tons were tested in a torpedo boat and was proved to be useless for navigation purposes.

The Engineer commissioned to examine this question reported that enormous quantities of excellent peat exists on the coast which, in his opinion may prove of commercial value.

CHAPTER XXIII

Metallurgy in the Republic

In the larger work of the writer, published in 1889, an extensive discussion was introduced in the chapter treating upon the metallurgical processess employed in the older mining countries, giving special prominence to the newest and most economical modes of applying electricity in the reduction of crude ores to a regulus and metallic state; describing also the great advantages offerred by electrolisis in the separation of one kind of metal from another; and although a considerable amount of time has elapsed, during which period the processes referred to have been much simplified and improved, still, it is to be regretted that not even the simplest and least expensive electrical process has been introduced for the reduction of the minerals of this country. This state of things is due to a variety of causes which, at present, are not necessary, prudent or useful to enumerate; but in the opinion of the writer, the time is fast approaching when the importance of treating crude mineral by electricity will be fully recognised and adopted.

Such a plant as may be required to carry out a simple

electrical process is not a costly matter; but a complete establishment for the electrolitie process would be, and could not be introduced into the country unless a constant supply of metallic produce from various establishments of fundition could be guaranteed over a series of years.

It would have no useful purpose to discuss the metallurgical processes of the ancients, nor that carried out by the Indians, who once possessed the richest mines in South America, we shall, therefore, content ourselves in speaking of the processes adopted in recent times in this country.

The reverbatory furnace, so much employed in Europe, has been adopted in the Republic with excellent results and when well constructed are durable: also, when the refractory lining is worn out, the repairs are easily made, and in outlying districts their use is comparatively cheap and effective: besides no great amount of skill is required to enable persons to reduce ores in this class of furnace.

One of the principal establishments employing reverbatory furnaces is situated at *Tilimuque,* near to Chilecito or Villa Argentina, in the province of La Rioja, and when the mineral had to be reduced the copper ores were transported from the mines to the establishment, and there selected, prepared, and mixed in such a proportion as would assay from 12 to 15 °/₀ of copper, the form in which the mineral could be best calcined and treated.

After calcination, the mineral is placed in the heated furnaces and the temperature raised, and when as much of the impurities as possible have been reduced to a liquid condition, it is run off as slag, and afterwards, the molten mineral passes out by an independent orifice.

If this process has been properly carried out, the resulting regulus may contain from 25 to 30 °/₀ of copper. The regulus is now broken into convenient pieces, placed upon a pile of

wood and calcined, after which it is returned to the furnace a second time and treated as in the first operation. The resulting regulus is still more concentrated and may contain 45 to 50 °/₀ of copper. When the base elements, or impurities, are very refractory, the regulus may be again calcined and submitted to a third reduction in the furnace, and the resulting regulus would assay from 60 to 65 °/₀ of copper.

If the crude copper ores are mixed to yield 20 °/₀, then the proportion of crude ore to the regulus produced, would be 3·23 to 1; but if it were to be no higher than 15 °/₀, then the proportion would be 4·36 to 1.

This process has been carried out to great perfection at the establishment "*El Progreso*", at Tilimuque, the property of Mr. William A. Treloar, the gentleman referred to in a former chapter, and in that establishment he has reduced the copper ores obtained from his "*Upulungos*" mine for many years with great sucess. This mine has passed into other hands, but Mr. Treloar still possesses the Tilimuque establishment.

The following figures show some of the results obtained from the ores smelted in this establishment.

From 60 to 65 °/₀ of copper
" 250·880 " 268·80 ounces of silver per ton
" 5·376 " 6·72 " " gold " "

However, the yield of silver and gold vary from the above assay.

In this Republic, the native miners have the custom of expressing the weight of minerals and metals by what they term the *cajon*, which is variable in different parts, but is generally taken to mean 50 Spanish quintals, or 5000 English pounds, or 2·232 tons. The silver produced was also sold by the *marco*, equal to 8 english ounces, 2 marcos being equal to 16 ounces avoirdupois.

At the Tilimuque establishment, there were two reverbatory furnaces, each of which is capable of reducing 4 *cajones* of ore, 200 quintals of 20,000 pounds. The quantity of wood required to reduce that weight of ore would amount to 228 quintals or 22,800 pounds.

Then $\frac{22,800}{20,000} = 1{\cdot}14$, or at the rate of 1·14 quintals of wood for 1 of regulus.

Experience shows that 10,000 pounds of mineral can be calcined in 24 hours by the expenditure or consumption of 6500. Then for the ratio we have $\frac{10,000}{6,500} = 1{\cdot}538$.

As it is important to show the produce of the mine "*Upulungos*", and its variations as being one of the principal mines and forms a good guide in determining the productive qualities of all the others in the same district, the following assay has been selected, and represents the average obtained from the treatment of a large parcel of ore.

Copper . .	15 %	
Silver. . .	66·2323	Ounces per ton of crude mineral.
Gold . . .	1·2390	

However, as previously indicated, the produce of crude ore varies, and for this reason large parcels of minerals have yielded as much as 71·08 ounces of silver and 1·28 ounces of gold per ton.

On one occasion, copper ores were extracted from the "*Upulungos*" yielding at the rate of 1·4 to 1·62 ounces of gold per ton, and the regulus reduced from it, at the rate of 4·25 to 1, yielded 5·95 to 6·78 ounces of gold per ton of regulus.

The system, as carried out in this establishment, may be taken as typical of all the others of the same class in the province of La Rioja. Considering, therefore, that it is not probable that the cost of labour and materials have changed to any considerable extent from the normal since the period to which

we are referring, the cost of carrying on the operations at this establishment will be given as it was formerly.

However, the form may be changed, introducing such elements as would represent any alterations that could have arisen in costs and values.

The following estimate is given as representing the results formerly obtained.

Total cost of delivering 100 pounds of regulus in the English market	11·21	dollars
Average price obtained upon the sale of 100 lbs. of regulus.	18·50	"
Net benefit obtained upon the sale of 100 lbs. of regulus in England	7·29	"

Then for the percentaje, or gain, as exhibited above, we have

$$\frac{7{\cdot}29}{11{\cdot}21} = 65{\cdot}03\ {}^{0}/_{0}.$$

As formerly was the case with all the mines of copper in the *Mejicana* district, the "*Upulungos*" was not exploited according to the best system of mining as it exists to day, consequently, the cost of exploitation, transport and other incidentals, were excessive.

Sometime since, the writer made an estimate of the cost of production, which at that time appeared to him to be within the approximate limits of what could be realised in the future, assuming that the sale price would have no great alteration and that the long promised railway to Villa Argentina would be made.

The estimate was as follows.

Cost of mineral.	3·20	dollars
Cost of wood for all the operations of founding and calcining, etc.	0·48	"
Cost of labour and management.	1·70	"
Cost of transporting 100 pounds of regulus to Cordoba	1·40	"
Cost of transporting 100 pounds of regulus to England	3·22	"
Total cost of 100 pounds of regulas in England.	10·00	"
Market price according to the Tilimuque scale .	18·00	"
Probable profit to be derived upon the sale of 100 pounds of regulus in England.	8·00	"

The following table, N.° 1, is exceedingly important as exhibiting the results which have been achieved in the establishment at Tilimuque.

N.° 1

Brute weight in kilos	Net weight in kilos	ASSAYS MADE IN TILIMUQUE		
		Gold, ounces per ton	Silver, ounces per ton	Copper %
8·496	8·280	3·5812	248·30	66·0
9·649	9·275	6·5000	221·70	62·0
10·422	10·146			
16·183	15·555	5·0166	205·22	58·5
14·448	14·404	4·9250	195·33	59·0
1·300	1·221	4·2562	183·74	54·0
13·489	12·993	5·1500	226·87	60·4
11·598	11·262	3·9604	253·27	55·0
10·736	10·566	4·0125	240·20	53·6
4·308	4·190			
8·153	7·933	5·2312	270·60	63·0
5·882	5·790	4·3000	289·60	57·0
9·208	0·064			
10·259	10·059	3·5812	296·71	61·5
5·773	4·675			
7·711	7·474	3·5500	270·90	60·0
	143.877	54·0643	2910·44	710·0

From the above data we deduce that the average was as follows.

Copper	59·16 °/₀	
Silver	242·53	Ounces per ton.
Gold	4.51	

Table N.° 2, exhibits the weight of regulus sold in England, as, also, the assays made there and the net price derived from its sale.

N.° 2

Tons of regulus sold	Assays made in England			Price of the ton in £ sterling	Value of the regulus in £ sterling	Value of the leather bags	Total value in £ sterling	Expenses in England in £ sterling	Net product of the sale in £ sterling
	Ounces of gold per ton	Ounces of silver per ton	Copper per cent						
8·0031	4·8000	247·00	65·0	96·6500	773·5000	5·3625	778·8625	39·3542	739·5083
9·1525	5·6000	227·73	62·37	91·3250	835·9500	6·9375	842·8875	42·6708	800·2167
9 8566	5·5000	230·10	62·43	93·6250	922·8333	5·3542	928 1875	47·1625	881·0250
15·1642	5·1000	207·50	68·97	83·4000	1264·7042	8·0958	1272·8000	60·2883	1204·5167
14·9973	4·0000	207·00	62·00	74·1250	1111·6750	7·0958	1119·7708	59·7958	1059·9750
—	—	—	—	—	—	—	—	—	—
12·6674	4·1000	274·00	58·25	100·2250	1269·5906	6·9375	1276·5292	59·2000	1217·3292
Total.	29·1000	1393·33	370·51	539·3500					

The average yield as demonstrated by the foregoing table was at the rate of:

Copper.	63·25 °/₀	
Silver	232·12	ounces per ton.
Gold	4·85	

The average selling price was at the rate of £ 89·81 per ton of regulus.

The railway referred to, has now been constructed from the Cordoba main trunk line to Villa Argentina, so that the old rate of transport of, from 1·40 to 1·43 paper dollars per 100 pounds of regulus, will be reduced to a reasonable and much lower rate.

The aerial wire line for the transport of the minerals from the mountain regions to the main railway line at Villa Argentina, is now in progress, and will soon he completed, thus introducing a more permanent and cheaper mode of transport for the ores of the various mining districts of the Famatina mountains.

Until the aerial line is put in motion, and some tons of mineral transported by it, any estimate of cost would be premature, but it will be considerably less than by pack mules; consequently, the advantages to be realized will more than counterbalance any augmentation in the value of labour and materials, and a reduction in value of products which could occur, consequently, under any normal conditions, there would always exist a good margin of profit to the companies engaged in the exploitation of the mines and reduction of the mineral to the form of regulus or copper bottoms and bars.

There is evidence that such companies will introduce the plan of founding or reducing the copper ore by means of *Water Jacket furnaces* instead of by the ordinary reverbatory furnaces; and as the operations would be less costly by the former than by the latter, a reduction in the production of regulus would take place.

Furnaces of this class were, it is believed, first introduced into the small establishment of fundition of *San Miguel,* situated close to Villa Argentina, for lhe reduction of silver ores, but this establishment has been closed for some years.

In 1883, the late Mr. Fouert installed, on the behalf of a French Company, an establishment for the reduction of silver and other ores, near to the small village of Nonogasta, situated at about 3 leagues to the South of Villa Argentina. The silver mines belonging to this company were exploited for some time and the ores from these, and those purchased from the miners were reduced in a Water Jacket furnace of 36 inches

diameter, and it is reported that from 1883 to 1894, the ores reduced produced 23,500 kilos of silver.

Copper ores were also founded in this establishment, and the usual type of regulus obtained. It is still a centre of action, where the miners may sell their minerals at a fixed scale according to the valuable contents of the ore. Two or more calcining furnaces exist in this establishment.

Not long since, another establishment, with a single Water Jacket furnace, was installed called *Santa Florentina,* and situated in the opening of the mountains, at a short distance to the west of Villa Argentina. The reduction furnace is acted by a Roots Blower, worked by a Pelton water wheel, the water being led from a dam. The fuel employed is charcoal obtained from *Vichigasta.* In this establishment there also exist open calcination floors. It is reported that this establishment has passed from the hands of Mr. Jaime Cibils Buxareo the former owner to the Famatina Developing Company. Due probably to this change the former owner of this establishment did not supply any data referring to the assay value, or the quantity of copper ores reduced by him.

After the late Mr. Fouert retired from the French Company, he installed a very complete establishment for the reduction of ores, at a place called *Corrales,* which consisted of six calcining furnaces and a Martin Siemens gas furnace.

The minerals were obtained from the Mejicana district.

The assay value of the regulus produced at this establishment was as follows:

Copper from	49·00	to 54·00	%
Silver	0·300	" 0·334	"
Gold	0·018	" 0·021	"

The capacity of this establishment permitted the treatment of from 200 to 250 tons of regulus per annum, but the usual

difficulties of transport of the mineral by pack mules restricted the out put of regulus to 150 tons per annum.

Not long after this establishment had been brought in to a proper working condition, the Director, Mr. Fouert, suddenly died, and the establishment was soon afterwards closed.

This was the first establishment in the country in which a Martin Siemens gas furnace was introduced.

Mr. Victor Koch & C., also introduced a small establishment at *Polaico*, consisting of two reverbatory and closed calcining furnaces, where the copper ores from the company's mines were reduced to regulus of the same percentage as that produced in the establishment of Tilimuque. It has been reported that this establishment has been closed for the moment.

Reduction furnaces were also installed for the treatment of minerals near to *Vinchina*, but there is no evidence to hand, showing their present condition.

It is considered that the companies already formed, and those now in formation for the exploitation of the copper mines of the Mejicana and other districts, will extract a sufficient quantity of minerals for several reduction establishments and, consequently, all the evidence goes to prove that the province of La Rioja is one of the principal mining centres of the Republic.

Recently, the "Famatina Development Company, Limited" has purchased the smelting works situated at Patyaco, some 35 kilometres from Chilecito, and in it have been founded several parcels of copper ores obtained from their mines. The following table N.° 3 represents ore founded from the "Upulungos".

N.° 3

DATE	Tons (metric)	Copper	Silver	Gold
1903		per cent	oz. dwt.	oz. dwt. gr.
Sept. 28	53·410	4·66	13·14	0 9 19
Oct. 23	3·000	4·0	12·15	1 1 13
Nov. 20	38·043	4·0	15·7	0 12 9
Dec. 4	24·424	5·4	13·14	0 11 2
" 18	2·252	5·6	15·13	0 16 8
" 18	6·182	5·6	15·13	0 16 8
1904				
Jan. 8	4·289	5·5	20·17	0 12 9
" 8	5·303	5·5	20·11	0 12 9

Table N.° 4 shows the amount of mineral extracted from the mine "*Compañia*" from Oct. 1903 to Jan. 8, 1904, the rate per cent of yield of copper, silver, and gold, and reduced to regulus at the company's reduction works.

N.° 4

DATE	Tons (metric)	Copper	Silver	Gold
1903		per cent	oz. dwt.	oz. dwt. gr.
Oct. 23	13·949	4·0	18 13	0 9 13
Nov. 20	15·490	4·1	15 13	0 11 2
Dec. 4	9·912	4·6	15 0	0 8 11
" 11	12·921	6·1	16 13	0 5 5
" 21	12·530	5·5	14 1	0 8 11
1904				
Jan. 8	1·020	6·1	14 14	0 5 21

The table N.° 5 contains a detailed account of the ores extracted from the mine "*Placilla*", with the corresponding assay value of copper, silver and gold.

N.° 5

DATE	Tons (metric)	Copper	Silver	Gold
1903		per cent	oz. dwt.	dwts. grs.
Sep. 28	13·220	3·02	24 13	16 8
Oct 9	12·960	2·2	31 12	16 8
" 9	13·660	4·09	55 17	13 1
" 9	17·812	3·65	52 2	16 8
" 23	6·325	2·2	25 9	18 22
" 23	5·103	2·3	37 11	5 5
Nov. 20	3·165	2·7	72 16	6 12
" 20	8·313	5·6	171 8	13 1
" 20	·255	2·8	71 4	5 21
Dec. 4	4·847	6·4	329 3	6 12
" 11	3·177	6·5	348 8	5 21
" 11	7·060	3·0	61 16	4 13
1904				
Jan. 8	5·101	7·2	263 1	5 5
" 8	1·347	4·6	121 16	3 22

The copper ore extracted from a newly discovered lode, called "*White lode*", is represented in the following Table N.° 6 with the assay value of copper, silver and gold.

N.° 6

DATE	Tons (metric)	Copper	Silver	Gold
1903		Per cent	oz. dwt.	oz. dwt. gr.
Sept. 28.	13·240	1·89	14 14	0 16 8
Oct. 23.	41·300	2·00	14 14	1 0 21
" 23.	17·289	2·9	14 1	1 2 5
Nov. 20.	14·741	3·6	26 2	1 6 3
" 20.	17·360	3·8	24 16	0 19 14
Dec. 4.	9·300	4·8	35 18	1 1 13
" 11.	13·644	4·9	29 3	0 15 0·6
" 21.	8·449	5·0	25 9	0 18 7
1904				
Jan. 8.	1·207	5·0	21 17	1 6 3

The ore extracted from the well known mine "*San Pedro*" by the new company is given in detail in Table N.º 7 together with assay rate of copper, silver and gold.

N.º 7

DATE	Tons (metric)	Copper	Silver	Gold
1908		Per cent	oz. dwt.	oz. dwt. gr.
Sept. 28	29·663	14·49	2 2	0 9 10
Oct. 9	22·320	13·54	2 3	0 9 3
" 23	6·139	14·6	2 12	0 7 4
" 23	8·825	12·2	1 19	0 5 21
Nov. 20	40·612	14·6	3 5	0 8 11
" 20	1·746	11·0	2 12	0 6 12
" 20	14·270	14·0	3 5	0 7 20
Dec. 16	6·581	16·9	3 12	0 9 3
" 11	22·544	17·3	3 12	0 9 19
" 11	12·686	15·2	3 5	0 9 3·5
" 11	1·895	31·8	2 19	1 0 6
" 21	11·376	17·2	2 19	0 9 19
" 28	25·626	17·4	2 19	0 10 10
1904				
Jan. 8	7·789	18·3	2 19	0 11 18
" 8	16·892	13·9	2 19	0 8 11

The assay value of mineral extracted from the gold mines in the *Ophir* district, has been given in another part of this work; but recently, the new Famatina Development Company, has extracted a few tons of ore, the details of which are given in the following Table N.º 8.

N.º 8

DATE	Tons (metric)	Copper	Silver	Gold
1903		Per cent	oz. dwt.	dwt. gr.
Oct. 30	1·158	5·5	8 16	7 20
" 30	1·025	4·2	7 10	5 5
Nov. 20	6·958	6·3	9 2	6 10
Dec. 11	1·873	5·7	8 16	5 21
1904				
Jan. 8	2·542	6·7	10 17	5 5

The following mines also belong to the same company, and general assays gave the following results.

N.º 9

	Copper	Silver	Gold
		oz. dwt.	dwt. gr.
"Jesus Maria"	6·99	2 19	15 12
"Carmen N.º 2"	1·63	7 0	14 0
"Trinidad N.º 2"	8·36	7 0	1 9

The quantity of copper ore represented in the preceding tables was, according to report, obtained as the average contents from the whole body of the lode during the years 1903 and 1904, and reduced in the establishment of the company to regulus.

The data in the tables referred to above was obtained from a published report of the company.

PROVINCE OF CATAMARCA

Metallurgical Establishments

The most important establishment, of the old type, for the reduction of copper ores in this province is that situated at "*Pilciau*", at a distance of about 3 leagues in a south eastern direction from the town of *Fuerte de Andalgala*, and, at the time it was installed, it must be considered to be the most complete and extensive one in the Republic.

It has been previously noted that the father of the present Mr. Samuel Lafone Quevedo, first commenced to smelt copper ores from the mines of *Capillitas* at an establishment erected near to *Santa Maria;* but as that was not a convenient situation, the present establishment was placed at Pilciau, in 1860.

This establishment consists of 6 reducing furnaces, 2 refining furnaces and others for calcination operations, with other necessary auxiliaries and buildings required for the workmen and administration.

Processes Employed in This Establishment

1st. Calcination of the crude ore.

2d. Reduction of a portion of the crude ore to regulus, and calcination of the same.

3d. Pulverization and calcination of half the regulus obtained from the first reduction.

4d. Refundition of a portion of the calcined regulus with a part of that not calcined.

5th. Refining operation.

In order to calcine the mineral, it is placed in piles of from 500 to 1000 quintals with intermediate layers of wood which are fired at several points at the same time, and the calcination is continued in this manner for from 3 to 5 weeks, during which period the greater part of the volatile and noxious elements, such as sulphur, antimony and arsenic are eliminated. These piles of calcined mineral are then opened, and the parts imperfectly calcined are placed in smaller heaps upon other beds of wood to undergo a second calcination.

At the time when the writer examined this reduction establishment, he found it to be too delicate a matter to inquire into and obtain a detailed statement of the costs and quantities consequently, in discussing this matter he is obliged to speak in general terms.

The charge for the second reduction operation consisted of the following class of elements.

1st.	Calcined regulus . .	18	quintals
2d.	Escoria.	5	"
3d.	Sand	6	"
4d.	Regulus	21	"
		50	"

However, the proportion of the above mixture varies according to the percentage of copper contained in the regulus. Five similar charges were passed through the furnace in 24 hours, and each of these produced 1 to 1 $^1/_2$ bars of copper, more or less pure, which would weigh three quintals, as well as from 10 to 15 bars of regulus. The regulus obtained from the second reduction, as described above, would assay from 70 to 80 $^0/_0$ of copper.

During the reduction, or founding operation, the escoria forms a colour between obscure blue and green and would assay from 2 to 4 °/₀ of copper. The escoria is refounded with a charge of crude mineral.

The copper bottoms obtained from the second reduction, are again melted in quantities of from 25 to 45 quintals, with a view of giving to the bars the form and weight most convenient for transport.

The proportion of copper contained in the copper bars, after the last reduction, would give from 90 to 91 °/₀ of copper, with from 10 to 15 ounces of gold, and from 200 to 300 ounces of silver per ton.

From 36 to 40 °/₀ of the regulus would form what is generally termed black copper, containing from 75 to 80 °/₀ of metal. This regulus was obtained from the second reduction.

The refination is carried on in a special furnace of the same construction as the others, except that it has apertures for the entrance of the air.

The time occupied in the refination process is from 24 to 30 hours, and there would be produced from 26 to 30 bars of copper weighing from 50 to 60 quintals. This refining process produces metal assaying from 95 to 97 °/₀ of copper, and from 90 to 115 ounces of silver per ton. The remains consist principally of iron, zinc and sulphur.

On one occasion, 2201 quintals of common copper assayed 0·3754 °/₀ of silver, and 0·00037 °/₀ of gold.

A parcel of bottoms weighing 798 quintals, yielded 0·6843 °/₀ of silver and 0·0447 °/₀ of gold. Another large parcel assayed 95·2 °/₀ of copper, with 0·4716 °/₀ of silver and 0·0004 °/₀ of gold.

Some parcels of regulus from a second reduction yielded 75 °/₀ of copper, 0·304 °/₀ of silver and 0·001 °/₀ of gold.

The class of copper obtained in the form of bottoms yielded at the rate of 189·58 ounces of silver and 12·005 ounces of gold per ton. Others, however, in a purer condition assayed at the rate of 193·178 ounces of silver and 12·176 ounces of gold per ton.

It was reported to the writer that for a period of 9 years, 22,000 tons of mineral were transported from the mines of Capillitas to the establishment of Pilciau, and that this quantity produced 3,526 tons of ordinary copper and bottoms.

Unless it were permitted to inspect the books of the company, it would not be convenient to enter into the question of costs and benefits realised; but no doubt it was sufficient to repay the company a large percentage upon the annual capital employed.

The following table, N.° 1 exhibits some of the results obtained at this establishment from the year 1872 until 1881, and is important as a proof of the market price obtained for the produce indicated in it.

N.° 1

Years	Bars	ENGLISH WEIGHT				Copper %	Excess in silver and copper	Price of copper	Excess upon contract price for silver & copper	TOTALS
		Tons	Cwts.	Qrs.	Lbs.					
1872	2,491	204	13	2	24			£ 87 9 0	£ 5 1 10	£ 92 10 10
1873	3,809	317	17	3	5			» 81 3 4	» 6 16 8	» 88 0 0
1874	2,197	181	14	3	20			» 81 7 8	» 6 13 11	» 88 1 7
1875	1,560	129	17	2	10			» 82 17 8	» 6 17 9	» 89 15 5
1876	1,870	155	14	1	8			» 76 15 7	» 6 15 0	» 83 10 7
1877	2,804	232	0	2	5			» 68 16 1	» 7 19 9	» 76 15 10
1878	2,918	240	5	3	21			» 61 5 10	» 6 4 3	» 67 10 1
1879	1,065	90	15	0	1			» 67 16 1	» 11 10 3	» 79 6 4
1880	1,421	120	17	2	6	95 1/2 to 96 1/2	111·11 to 154	» 66 5 6	» 11 13 1	» 77 18 7
1881	1,673	145	9	3	27	95 3/4 » 96 1/4	110 » 132·1	» 71 14 10	» 8 12 2	» 80 0 7
	21,819	1,819	7	1	15					

Mean average in the 10 years.

Copper . . . . . £ 75 0 7
Excess copper and silver. " 7 7 8 £ 82 8^{s} 3^{d}

The table N.° 2, also shows similtar results for another class of copper.

N.° 2

Years	Bars	ENGLISH WEIGHTS Tons	Cwts.	Qrs.	Lbs.	BOTTOMS Copper	Gold	Silver	Price of copper	Excess upon contract price Gold, silver, copper	TOTALS
1872	501	40	8	0	11				£ 89 6 7	£ 51 17 0	£ 141 5 7
1873	832	67	19	2	3				» 81 5 10	» 44 5 7	» 125 11 5
1874	544	44	15	3	20				» 80 17 2	» 46 10 0	» 127 7 2
1875	404	33	3	0	10				» 84 1 1	» 58 8 5	» 142 9 6
1876	408	32	19	0	21				» 79 11 5	» 67 5 5	» 146 16 10
1877	689	56	6	3	19				» 71 2 5	» 62 17 0	» 133 19 5
1878	659	52	16	1	24				» 62 0 9	» 62 17 1	» 124 17 10
1879	249	21	11	2	24				» 69 18 6	» 141 16 8	» 211 15 2
1880	294	25	12	1	23	87 3/4 to 91 3/4	13·14 to 37·12	223·8 1/2-330.3	» 70 8 9	» 115 0 0	» 185 8 9
1881	365	33	5	3	15	88 1/2 » 91 1/2	7·18 » 24·23	210 to 248·19	» 76 3 4	» 63 6 5	» 145 9 3
	4,945	408	19	1	2						

Mean average in the 10 years.

Copper . . . . . £ 72 10 5
Excess in gold and silver . . " 64 17 4 £ 141 7s 9d

Mean average in the bars and Bottoms in 10 years.

Copper. . . . . £ 75 6 1
Excess of gold silver and copper " 17 18 8 = 93 4s 9d

The table N.° 3, shows similar data to that contained in Table N.° 1, but from the years 1882 to 1886.

N.° 3

Years	Bars	ENGLISH WEIGHT Tons	Cwts.	Qrs.	Lbs.	Copper %	Excess in silver and copper	Price of copper	Excess upon contract price for silver & copper	TOTALS
1882	2,130	188	14	2	20	59 1/2 to 96 1/4	105·8 to 117·12	£ 75 9 0	£ 6 9 0	£ 81 18 0
1883	630	53	9	3	20	96 1/4 » 97	96 » 106·13	» 65 14 0	» 1 21 1/2	» 66 8 6
1884	1,661	133	15	1	27	95 1/3 » 96 3/4	80 » 92 1/4	» 56 14 10	—	» 56 14 10
1885	1,602	137	17	2	18	94 3/4 » 96 3/4	74 1/2 » 98	» 48 18 0	» 0 3 0	» 49 1 0
1886	1,046	95	12	1	25	95 7/8 » 96 1/4	80 » 88·10	» 46 2 3	» 0 2 5	» 44 6 11
	7,069	600	10	1	26					

Mean average in the 5 years.

Copper. . . . . £ 61 1 6
Excess copper and silver. . " 10 8 7 £ 7 10 1

The table N.º 4 exhibits similar elements as those contained in Table N.º 2 for the 1882 to 1886.

Years	Bars	ENGLISH WEIGHTS				BOTTOMS			Price of copper	Excess over contract price for Gold, silver, and copper	TOTALS
		Tons	Cwts.	Qrs.	Lbs.	Copper %	Gold	Silver			
1882	532	51	1	0	8	90 3/4 to 92 3/4	6·19 to 10·8	196·14 to 216.8	£80 12 0	£ 45 7 0	£ 125 19 0
1883	247	21	6	2	3	91 1/4 » 93 1/4	5·15 » 7·16	137·10 » 178·8	» 78 9 2	» 24 11 8	» 101 0 10
1884	378	30	9	0	18	91 3/4 » 92 3/4	7 7/8 » 8·19	137 » 171	» 63 12 8	» 34 9 7	» 98 1 0
1885	380	34	3	2	3	92 » 95 3/4	1·1 » 18·6	81 » 160	» 49 0 3	» 51 15 4	» 100 15 7
1886	192	19	11	2	20	93 » 94	10·11 » 15	142 » 159·5	» 48 5 1	» 53 14 3	» 101 19 1
	1,720	156	11	2	20						

Mean average in the 5 years.

Copper . . . . . £ 65 16 0
Excess silver and gold . " 42 15 9 £ 108 11ˢ 10ᵈ

As previously noted, the preceding tables N.ºˢ 1, 2, 3 and 4 contain valuable data which may be utilized for a variety of purposes.

In addition to this establishment, the newly formed Capillitas Copper Company, Limited, is installing a new establishment of fundition with high water jacket furnaces and electric installation for giving motion to the machinery and the aerial wire line for transporting the minerals, no doubt this will form the most important mineral reduction works in this province, and as the copper mines of this company are more fully developed, other founding furnaces will be a necessary addition.

The London Capillitas Copper Company is very fortunate in securing the large forest of Algarrobo trees situated in the

neighbourhood of Pilciau, the most important in the province, as it is capable of supplying sufficient fuel for many years to come.

Hydro-Metallurgy

Applicable for the reduction of the poor copper ores of this country

Within the last few years, various processes have been invented and applied for the extraction of the metal contained in low grade copper ores, other than by direct smelting, with great success.

Some of these hydro-metallurgical processes have been applied to copper ores containing no more than *one half per cent* of metal, and a profit obtained.

It may be anticipated that in these days of electric speed, any system for the treatment of minerals should have for its basis, simplicity in its application, facile manipulation, and cheapness in production, as elements of the greatest importance to the metallurgist and capitalist.

According, therefore, to the nature of the mineral containing copper, one of the many well known systems may be adopted to suit the conditions and circumstances of the case.

The author is not writing an exhaustive technical work on the comparative merits of the various processes in existence, but only indicating, in a cursory manner, that a system of operation could be applied to the poorer copper ores of this country with the greatest advantage.

As previously indicated in one of the former chapters, there exist all over the mining districts of this country a vast number of copper veins containing low grade copper ores, ranging from 1 $^1/_2$ up to 3 °/₀ of copper, which evidently could not be economically treated in water jacket smelters of

the best modern type, because the materials to be moved and the expenses of transport, reduction, and all other incidentals, would be too great; for example, to produce regulus which should assay from 60 to 64 °/₀ of copper, the rate preferred, and best to an electrolytic reduction, or precipitation of the various metals one from another, it would be necessary to found 16 tons of crude ore at 4 °/₀.

In some other countries, such as Germany, the copper lodes are extremely thin and poor in quality, ranging from 4 to 5 inches in thickness, and yielding no more than from 2 to 5 °/₀ of copper, but it is a historical fact that these copper veins have been worked for many years, and their exploitation is still continued.

The copper ores of *Rio Tinto*, Spain, have assayed from 1 ½ up to 2·70 °/₀ of copper, and on account of the large deposit of mineral and cheap leaching process for the extraction, great profit has been derived.

Although this process is cheap, it is not to be recommended for the treatment of all classes of ores; besides it requires a long time to carry it out.

The copper ores of *Agordo*, Italy, assaying from 1 to 2 °/₀ of metal, are treated in some such similar manner.

The poor copper ores of *Stadtberg* is treated with a solution of sulphuric acid with considerable advantage.

The leaching process is carried out in Russia for the extraction of the metal from ores containing 3 °/₀, with good results.

The process by ferrous chloride and hydrochloric acid, acting upon copper ores of from 2 to 2 ½ °/₀ at *Stadtberg*, in Westphalia, has given excellent results.

The Claudet process is carried on in England upon Spanish ores containing copper and silver First, the ore is calcined with common salt, dissolving out the chlorides with hot water,

precipitating the silver as iodide, and the copper with metallic iron.

There are also the Henderson and other processes, all of which possess advantages, and either one or the other can be applied to most classes of copper ores.

In some of the processes, it is important to convert the copper into the condition of sulphate, from which the metal is easily extracted.

Some of the elements which retard, and are injurious to some of the processes, consist of ferrous oxides, magnesia, lime and manganese; but an analysis of the mineral to be treated will decide all such questions.

Those Argentine copper ores which are not be treated by concentrating machinery and so raised in percentage, could, as before noted, be utilized to great advantage and benefit, by one of the many Hydro-metallurgical processes now so largely employed in other parts of the world.

In conclusion, it is, therefore, to be hoped, that some company or companies will take up this question, and prove, to their advantage, that the low grade ores, now neglected, are capable of yielding a good profit upon the capital invested in the undertaking.

The writer regrets that this chapter does not contain so much data as he originally intended, but the short time at his disposal for the completion of the whole work was too limited, and, for this reason, a long correspondence could not be carried on with the various proprietors of mines and establishments of fundition in order to obtain additional information.

CHAPTER XXIV

Notes Upon The Mining Laws of The Republic

In the absence of documentary evidence, it would be difficult, it not altogether impossible, to determine, in an absolute manner, at what epoch and in what country mining laws originated; but they could not have been introduced in those countries where the ancient mines belonged to and were developed by the State, because second parties could not have been interested, and when they first were, if anything in the nature of restrictions was introduced, it must have consisted in rules for the safe conduct of mining operations and probably also affecting the miners, themselves.

Considering, however, that the Romans carried on mining operations in the countries conquered by them, traces of which still are found in Spain, Portugal, and England, it is highly probable that they projected and applied regulations such, indeed, as were suited and necessary for the guidance of their mining operations. In fact, in 1893, it came to the knowledge of the writer that a large bronze plate, with mining rules engraved upon it in Latin, was discovered in a good state of preservation in the ruins of old buildings which had

been used for the working of some ancient copper mines by the Romans in Portugal; but the writer had no opportunity of verifying this statement which was made to him by the engineer who said he had examined these workings in the year mentioned.

The mines of Spain were claimed by the crown as early as 1236, and such laws of mines as were required for the adjustment of mining rights appear to have been introduced as early as 1387. No doubt such laws were modified from time to time to suit varying conditions, as has been the case in that country in modern times.

The mining regulations of England were originally derived by prescription, and a claim to a right of title by virtue of immemorial use, and such claims were confirmed in succession by the British Crown in 1198, 1202 and 1305.

It is believed, that the French mining regulations were originally based upon the Roman law; but, for this, we have no better evidence before us than opinion.

However, previous to 1791, much confusion existed regarding mining rights.

Were there time and space at disposal, it would be exceedingly interesting as well as important to trace the reason why the Crown or State of any of the older countries of the world claimed the absolute right to the mines. We know there is a right claimed by conquest, and that any conqueror in ancient times could claim what he pleased, as did William, the Norman Conqueror soon after 1066, and, in virtue of this right, he divided the greater part of the conquered territory between the nobles who followed and supported him, and hence those who possessed the surface rights had also the absolute right to the minerals which may have existed under their estates, and no doubt this is the origin of the mining rights possessed by the Lord of the Manor in the older countries of Europe.

However, one peculiar feature existed, which constituted a reservation of Royal rights, which seem to have been confined to gold mines under the pretext that they were *Royal Mines,* belonging to the Crown or State owing to their special excellence, and to assist or provide funds for the defence of the country, and for the supply of coinage. The *Royal Mines* were, however confined to those of gold and silver, in contradistinction to all others which were termed *base mines.* Nevertheless, the State in England set up a claim to "any mines of copper, tin, iron and lead in which gold and silver were found to be intermixed".

This claim was confirmed in 1568, but ceased afterwards.

For full information upon such matters, it would be well to consult that excellent work "Guide to the Mining Laws of the World" by Oswald Walmesley of Lincoln's Inn, Barrister at Law (London) 1894.

After the conquest of South America by the Spaniards, and when they discovered gold and silver mines in abundance and which were considered to be so enormously rich, the king of Spain claimed the mines as his sole prerogative, which he, like a good Spaniard, expressed in such eloquent and dominant terms.

Naturally the mining rights as acquired by various persons, subjects of the Court of Spain in South America, brought about disputes and conflicting interests, and this occasioned various complaints and communications which were made by the *viceroy* from 1771 and following dates, to the king of Spain, resulting in the formation of the mining laws known throughout South America, as "Ordenanzas de Mineria de Mejico", which commenced to be applied in 1783, and affected all Spanish Colonies in South America. Such legal dispositions continued in force in their original form until 1844, when some additions were made, but, as a whole, continued

in force after the Independence of 1810 and, in the Argentine Republic, up to 1887, and thus ruled the mining industry for a period of 104 years.

Some of the dispositions of this old code of mining laws are exceedingly important, not only for the regulation of mining, but as exhibiting the power and great condescension of the King to part with his royal prerogative upon conditions which were imposed.

He says, (Article I of Title V). "The mines (constituting) a property of my royal crown, as also by virtue of their nature and origin (acquired by conquest) . . . . . and, without separating them from my royal patrimony, I concede to my vassals n property and possession in such a manner that they may sell, permute, lease, will and mortgage the rights which they possess in them under the same terms of possession". See "Ordenanzas de Mineria de Mejico", edition 1881, page 68.

In a contracted and concise form the two conditions upon which the mines were conceded are thus expressed.

"The contribution to my royal treasury (3 per cent of the value of the gold and silver extracted), and, on page 164 "the working of the mines continuously with 4 miners in each, or in default to do so for four consecutive months, entails forfeiture", so that if a miner or capitalist had opened up his mines, and placed the necessary machinery for its development and some fatal accident occurred to prevent the continuation of the workings for four consecutive months, his rights together with the capital expended were lost.

Thus it is clear that up to 1771, the equitable rights in a mine so acquired were not well understood by the King of Spain, and herein lies the base of the evil and injustice which has been brought down and applied to the present time. Of this we shall have occasion to speak at length further on.

For the period in which the old Mejican code of mines ap-

peared, it was undoubtedly sufficient for the purposes intended, and although it contained some good general principles, still, it was mixed with various Spanish incongruities. It has, however, been accepted as the basis of all the modern mining codes of South America.

It is not necessary, nor possible at present, to discuss the comparative merits of the various mining codes now ruling in South America, and for this reason any remarks must be understood in a general sense and confined, more or less, to the mining laws in force in this country and its working, with which the writer has been acquainted for a period of 18 years.

The actual code of mines came into force on the 1st. of May, 1887, and consists of 537 pages 8vo., containing 375 Articles, with a large amount of annotations or doctrines of law. It is a corrected and reduced code from the original one projected by the late Doctor Enrique Rodriguez, and published in 1885, containing 578 pages and 414 articles, some of which were in conflict with the constitution, and consequently a commission of Congress was named to study the original project of Doctor Rodriguez, and with the changes introduced by the commission it was published in its present form.

It would be impossible, however, to discuss the merits of all of the provisions of law it contains in a consecutive manner together with the commentations or doctrines of law appended to the text and, consequently, it is proposed to direct attention to a few of the legal dispositions under which mining rights and titles may be obtained.

The "Ordenanzas de Mineria de Mejico", or the old law in force up to the end of April 1887, provided that the length of a metalliferous vein of mineral, measured in the direction of the outcroppings, should amount to 200 varas, of 33 inches each, or for a total distance of 550 feet, the width being determined in evry case by the amount of *the angle of declivity of the mineral vein.*

The ancient miners, before and after 1783, determined the angle of declivity by letting fall a plumb-line from a point in the hanging wall of the mine under examination, to a depth of 1 vara, or 33 inches, and then measured the distance from the termination of the plumb-line to the vein of mineral, or underlie, by so many *palmos* and *dedos*, or *Spans* and *fingers*, as the case may be. Such measurements were then compared with a scale which formed part of the "Ordenanza de Mineria of Mejico", and the corresponding width for the concession was selected and measured upon the ground.

By referring to the original scale, we find that for *two Spans* and *three fingers*, the width of the mining concession amounted to 112·5 *varas*, or 309·375 English feet. The scale referred to preceded by *three fingers* at a time until, four palms (spans) were reached, which measure was intended to correspond with an angle of 45 degrees, and this gave the width of 200 varas, or 550 feet for the mine concession.

This old and uncertain plan was improved about 1844, and a table of angles of declivity added with the corresponding depth and width of the mines.

It was a principle of the old law that all metalliferous veins and other economic mineral substances of commercial value existing under the superficial rectangular area of 40,000 square varas, or 302,500 square feet, and included between perpendicular planes falling from each side of the rectangle and passing to the centre of the earth, until the mineral vein was reached, or intersected, would form and belong to a pertenencia or concession of a mine.

The improved scale of the "Ordenanza de Mineria de Mejico", to which we have referred, is given in *extenso*, as follows.

PERPENDICULAR OF THE TRIANGLE	Angle of declivity	Width of concession
2 spans and 6 fingers	58° 0'	= 125·0 varas
2 " " 9 "	55 30	= 137·5 "
3 " " 0 "	53 08	= 150·0 "
3 " " 3 "	50 54	= 162·5 "
3 " " 6 "	48 49	= 175·0 "
3 " " 9 "	46 54	= 187·5 "
4 " " 9 "	45 00	= 200·0 "

Those who compiled the *Ordenanzas*, gave no reason whatever why this scale of angles and measurements was adopted for determining the width of the mining concessions, neither is there any evidence proving that such a scale of dimensions was based upon mathematical, equitable, or commercial principles. Nevertheless, the following calculations made by the writer demonstrate what may have been, or was intended, when this question was originally treated.

It may be observed that the bases and widths of the mining claims, or *pertenencias*, given, consist of the five geometrical elements which necessarily exist for the determination of the numerical relation of the sides and angles of a right angled triangle.

To carry out the idea of the proper form that a concession should have, and demonstrated further on, it has been considered a matter of interest, as well as useful, to calculate or determine the length of the hypothenuse, or, what is the same thing, the length of the mineral vein taken in the direction of its inclination as, also, that of the perpendicular, or the deepest point of the mineral vein in each concession, for which determination the simple application of the trigonometrical functions, or the *sines* and *secants* are sufficient.

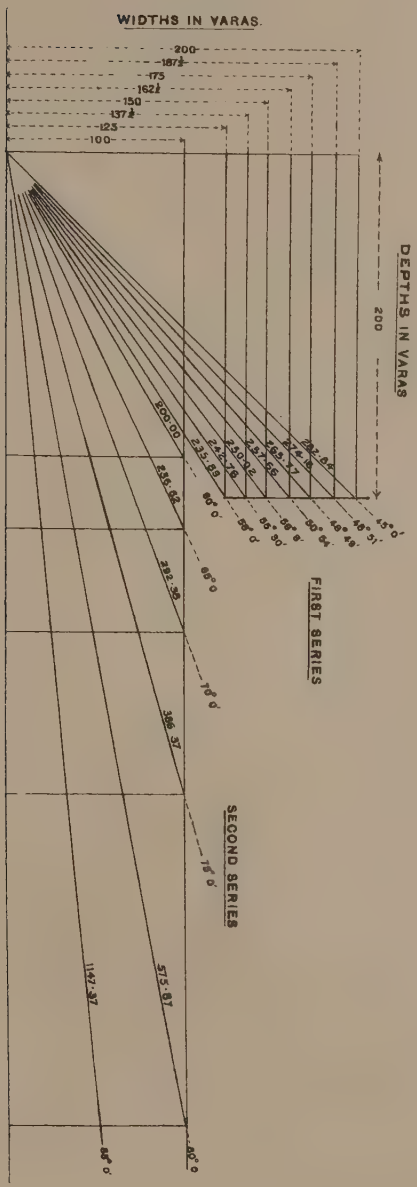
The following table explains the calculations mentioned, and

in order to avoid confusion, it is divided into two series, i. e., corresponding to the first and second scale of the *Ordenanzas*, because there, the width of the concession of mines are fixed at 100 varas for all the angles of declivity with larger angles than 58 degrees.

TABLE N.º 1

Scale of Degrees of the *Ordenanzas* for Mining concessions.	Secants corresponding to the Angles in column (1).	Width given in the *Ordenanzas* for Mining concessions.	Length, of Mineral veins, or Hypothenuses corresponding to the Angles in column (1) and data in column (3).	Sines of Angles given in column (1) for the Declivity of the Mineral veins.	Depths of perpendiculars calculated corresponding to the Angles in column (1), and widths of concessions in column (3).
First series calculated from the Ordenanzas					
Degs. Mins		Varas	Varas		Varas
45 00	1·41422	200·0	282·84400	0·70711	200·0018
46 51	1·46218	187·5	274·15875	0·72957	200·0180
48 49	1·51867	175·0	265·76725	0·75261	200·0191
50 54	1·58559	162·5	257·65837	0·77605	200·0018
53 8	1·66681	150·0	250·02150	0·80003	200·0247
55 30	1·76551	137·5	242·75763	0·82413	200·0638
58 00	1·88708	125·0	235·88500	0·84305	200·0423
Second series calculated from the Ordenanzas					
60 00	2·00000	100·0	200·00000	0·86603	173·2060
65 00	2·366620	100·0	236·62000	0·90631	214·4511
70 00	2·92380	100·0	292·38000	0·93969	274·7466
75 00	3·86370	100·0	386·37000	0·96593	373·2064
80 00	5·75870	100·0	575·87000	0·98481	567·1225
85 00	11·47370	100·0	1,147·37000	0·99619	1,142·9985
89 00	57·29860	100·0	5,729·86000	0·99985	5,721·0005

FIG. 1.


WIDTHS IN VARAS.
200
187½
175
162½
150
137½
125
100
DEPTHS IN VARAS
200
FIRST SERIES
SECOND SERIES
200.00
235.89
242.76
250.02
257.66
265.77
274.16
282.84
236.62
292.38
386.37
1147.37
575.87
80° 0'
65° 0'
70° 0'
75° 0'
65° 0'
80° 0'
55° 0'
55° 30'
56° 8'
50° 54'
48° 49'
48° 51'
45° 0'

The first column in the preceeding Table 1, contains the Ordenanza scale of angles of declivity of the mineral veins, and the other five columns contain calculated data, consequently columns Nos. 3, 4 and 6, contain the length of the three sides of a corresponding series of right-angled triangles. In fact the hypothenuse, or length of the mineral veins are given in column 4.

It has been found convenient to divide the table into two parts i. e., the first commences at 45 degrees, and terminates at 58 degrees, with a width for the mining concession of from 200 to 225 varas, or from 550 to 618·7 feet.

The corresponding length of the mineral veins, measured in the direction of its declivity, amounts to from 282·844 to 235·885 varas, or from 777·82 to 648·68 feet.

It is curious to note that these calculations prove that the compilers of the *Ordenanzas* intended that the depth of the mines under the angles given should be 200 varas or 550 feet, and the difference in column 6 is so small that we must conclude that some adjustment must have been observed.

The angles of declivity in the second part of the table, ranges from 60 to 89 degrees, and under all the others which could occur within these limits, the base of the triangle, or width of the mining concession is made the constant quantity, or 100 varas.

In this case, the corresponding length of the mineral vein ranges from 200 to 5,729·86 varas, or from 550 to 15,757·113 feet, and the depth from 173·206 to 5,721·0 varas, or from 476·316 to 15,732·75 feet, or 2·97 miles.

The Fig. N.º 1 attached to this page, is a graphic representation of all the mining concessions which could occur, and correspond to the angles of declivity in the scale of the "Ordenanzas de Mineria de Mejico", as represented, and it exhibits the ill proportion which exists between the length of

the mineral veins measured in the direction of the declivity, and the depths to which they extend.

It will be observed, that in the first part of the scale, 4th. column, the length of the mineral veins measured in the direction of their declivity, continually diminish as the angle augments until the difference between 45 and 58 degrees is 46·959 varas or 129·132 feet.

The expenses, or total cost necessary to exploit a vein of mineral with an angle of declivity of 45 degrees, with an average thickness say of *half a metre*, is less than that required to exploit a vein of mineral with an inclination of 58 degrees under the same conditions and, consequently, the benefit which may result would be less; but this important principle was altogether ignored, not only by the ancient compilers of the "Ordenanzas de Mineria de Mejico", but by all those who have formed the modern codes of mines throughout South America up to the present time, and, for this reason, up to 1888, the scale for the mines of Chile, was similar to that of the *Ordenanzas*.

Column N.º 1 in the following Table, N.º 2, contains the angles of declivity of the mineral veins under which mines are measured in Chile, and the numbers in column N.º 3, are the corresponding widths. The data contained in columns 2 and 4, are the calculated lengths of the mineral veins measured in the direction of their declivity and depths at which each terminates.

FIG. 2.

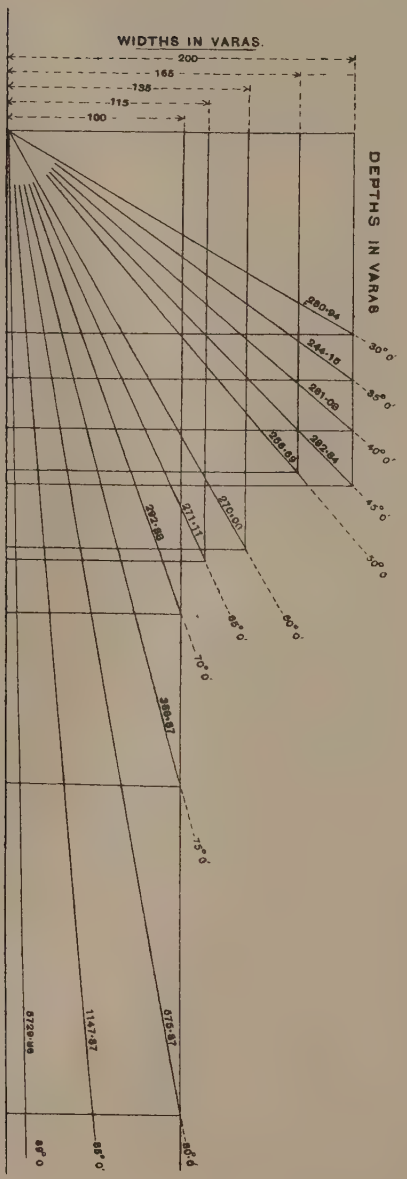

WIDTHS IN VARAS.
200
165
135
115
100
DEPTHS IN VARAS
280·94
244·15
281·08
292·84
270·00
271·11
292·88
386·87
1147·87
575·87
30° 0′
35° 0′
40° 0′
45° 0′
50° 0
60° 0′
65° 0′
70° 0′
75° 0′
80° 0′
85° 0′
89° 0

TABLE N.º 2

Angles of Inclination Chilian Code	Hypothenuses, or Lengths of veins	Base of Triangles, or width of Concessions	Perpendiculars, or Depths of veins
Degs.	Metres	Metres	Metres
30º	230·940	200	115·4700
35	244·154	200	140·0415
40	261·080	200	167·8199
45	282·840	200	199·9990
50	256·691	165	196·6393
60	270·000	135	233·8270
65	271·113	115	246 7183
70	292·380	100	274·7476
75	386·370	100	373·2051
80	575·870	100	567·1280
85	1147·370	100	1143·0052
89	5728·9965	100	5724·8600
(1)	(2)	(3)	(4)

It will be observed that from 30 to 40 degrees, a small augmentation of the mineral vein occurs, the difference being 26·169 metres; but there is no regular or systematic augmentation, for, under an angle of 60 degrees, the length of the mineral vein is 270·000 or 12·840 metres less in length than that under the angle of 45 degrees. The lengths then augment without ratio up to 89 degrees, under which declivity the lengths of the mineral vein amounts to 5728·9965 metres, with a depth of 5724·8600.

The Fig. 2, attached, represents all these dimensions in a graphic form.

The scale for Argentine mines is a follows.

Declivity of the Mineral vein	Width of a Mining Concession
45 degrees.	200 metres
50 "	240 "
60 "	245 "
65 "	275 "
70 "	300 "
75 "	300 "
80 "	300 "
85 "	300 "
89 "	300 "

Considering that the base of the triangles, or width of the concesions of mines, are longer than those assigned in the Chilian scale, the lengths of the mineral veins measured in the direction of their declivity and depths are increased and, consequently, it is still more irrational in its conception.

The compiler of the Argentine code of mines was an eminent legislator, but he was not a mathematician and, consequently, he fell into a grave error in stating the case of the angles of declivity under which mineral veins could exist. He says in Article 230 "When the inclination of the mineral vein respect to the vertical corresponding to the longitudinal line fixed for the pertenence does not exceed 45 degrees, the latitude shall consist of 200 metres". All the other angles in the code must, therefore, according to the law in the article named, be referred to the vertical line, that is to say, from a perpendicular line let fall, or supposed to fall from a point in the out-croppings of the mineral vein towards the centre of the earth; and this mode of putting the case could lead to much dispute and discussion, for, in the first place, it must be decided what Doctor Rodriguez meant by *vertical*, and what is the proper signification of the word. No doubt in its gene-

ral acceptation it means a line perpendicular to a given point in the horizontal plane and continued upwards to the zenith. This, therefore, could not have been the sense in which it was intended to be understood in the mining code, because if the measurement of the declivity of the mineral vein had been referred to this line, they would have been placed above the horizon, or in the air, and, consequently, as such veins exist in the crust of the earth, it is clear that Doctor Rodriguez meant that the angles of declivity of the mineral veins should be determined by measuring them from a perpendicular line from the horizontal downwards which he calls the *vertical.* As far as the first angle in the scale is concerned, i. e., 45°, a mineral vein would not be affected whether the angle was set out or measured from the vertical of the horizontal lines, because it is a central point betwen 0 degrees and 90 degrees, but when we come to the other angles of the scale which, also, must be measured from the vertical, or a perpendicular line below the horizon, then grave errors are introduced, because the lengths upon the inclination of the mineral veins in succession, would be shortened being in the wrong position, consequently, each mine, so treated, would contain a less amount of mineral than it was entitled to.

No doubt this mode of treating the angles of declivity of the mineral veins, could legally be enforced, but, in practice, it is completely ignored, and the general surveying and engineering system of referring all the angles to the horizontal instead of to the vertical line is adopted.

The writer has had occassion to apply the dispositions of the code to mining cases daily for more than 18 years, and consequently has devoted a great deal of time to its study as also, to the dimensions which the different classes of mining concessions should have, from which he has devised a project based upon scientific and equitable principles, such as could

be accepted and made part of any new code of mines which the government may elect to introduce.

The writer read a paper upon this subject before the North of England Institute of Mining and Mechanical Engineers, the principles involved in which, received complete approval. In fact the Council of the institute awarded a premium to the writer for "his important paper".

The elements in the following, table N.° 3, have been calculated in order to assist in determining the length of mineral veins in the direction of the declivity, which should be in proportion to the increased depth, labour and cost of installation and exploitation of a mine. The data contained in columns 3, 4, 6 and 7, have been specially calculated for this object.

TABLE 3

Inclination.	Hypothenuses or Lengths of Mineral veins.	Bases of the Triangles.	Perpendiculars, or Depth of veins.	Weights to be Balanced or Raised.	Power necessary to Balance Weights in Column (5)	Difference of Powers or Ratios between the consecutive numbers in column (6)
Degrees	Metres	Metres	Metres	Quints.	Quintals	
30°	100	86·60254	50·00000	5	2·50000	0·000000
35	100	81·91520	81·35764	5	2·86788	1·147152
40	100	76·60444	64·27876	5	3·21393	1·120664
45	100	70·71068	70·71068	5	3·53553	1·100064
50	100	64·27876	76·60444	5	3·83022	1·083408
55	100	57·35764	81·91520	5	4·09576	1·069328
60	100	50·00000	86·60254	5	4·33012	1·057220
65	100	42·26183	90·63078	5	4·53153	1·046514
70	100	34·20201	93·96926	5	4·69846	1·036837
75	100	25·88190	96·59258	5	4·82962	1·027916
80	100	17·36482	98·48078	5	4·92403	1·019548
85	100	8·71557	99·61947	5	4·98097	1·011564
89.5'	100	0·29089	99·99998	5	4·99999	1·003819
Perpend.	Perpend.		Perpendicular			
90°	100	0·00000	100·00000	5	5·00000	1·000000
(1)	(2)	(3)	(4)	(5)	(6)	(7)

In order to arrive at reasonable and suitable results, it has been necessary to consider the mineral veins as a series of inclined planes under and corresponding to the angles of declivity in column 1, of the table, commencing in the scale at 30 degrees. It will be seen that the unit of measure, or lenght of the mineral vein, or hypothenuse of the series of right angled triangles, have been taken as a constant of 100 metres, and belonging to the series; the column 3, contains the basis, and 4 the perpendicular depths of the veins of mineral. A constant weight of 5 quintals, or 500 lbs, has been placed in column 5, which has to be balanced upon the vein of mineral, or inclined plane represented in column (2) by another counter-balance exerted by an engine at the surface.

In column (6) we have the amount of the counter-weight or power exerted to balance the weight to be drawn and indicated in column (5), and upon the planes in column (2).

The ratio or difference between the powers in column (6) is represented in column (7).

Fine mathematical precision, due to friction and the force necessary to give motion and speed may be applied to the final results, but as it is only intended to offer an approximately correct mode for the determination of the area a mine should have, such niceties are not given.

The following Table contains the projected scale for mining concessions.

TABLE 4

Inclination	Hypothenuses, or Length of veins	Perpendiculars, or Depth of veins	Base of Triangles, or Width of concessions
Degs.	Metres	Metres	Metres
30°	230·94000	115·47000	199·99990
35	264·92328	151·95347	217·01206
40	296·88998	190·83618	227·42969
45	326·59798	230·93968	230·93968
50	353·83886	271·04179	227·43108
55	378·36980	309·92639	217·01279
60	400·02012	346·40971	199·99974
65	418·26666	379·38308	176·90948
70	434·04761	407·84990	148·44520
75	446·16448	430·94082	115·47022
80	454·88618	447·95447	78·98646
85	460·14640	458·37219	40·10238
89.5'	461·90370	461·87790	1·34356
(1)	(2)	(3)	(4)

The first angle has been fixed at 30 degrees, and this would give a lenght for the mineral vein of 230·94 metres and depth of 115·47 metres.

The second mineral vein in the scale has a declivity of 35 degrees, and considering that a greater power is necessary to balance 500 pounds, with extra cost than would be the case upon an inclined plane of 30 degrees, the mineral vein should have a greater proportional length to compensate for the excess in cost.

It willl be seen that the ratio in column (6) of Table 3 is 2·86788 and if we divide it i. e., $\frac{2{\cdot}86788}{2{\cdot}5000} = 1{\cdot}14715$.

The calculated length of the first mineral vein in Col. (2) in table 4, = 230·9400 metres, and if we multiply this length by 1·147150, we should have 264·92282 metres for the length of the mineral vein under an angle of declivity of 35 degrees,

with a corresponding width for the concession of 217·01206, and depth of 151·95347 metres respectively. The excess in length of the vein of mineral due to this principle of adjustment amounts to 33·98282 metres.

The other ratios contained in column (1) of the table must be treated successively in the same manner, until the end is reached, and in that case we have a ratio of 1·003818, which multiplied by 460·14640 gives 461·90370 metres for the length of a mineral vein measured upon the declivity and corresponding to the angle 89° 50′, which is only 10 minutes from the perpendicular, with a difference of 0·003818 in ratio.

In all the mining and scientific literature of the various nations that has come into the hands of the writer, he has not been able to trace any special rules framed for the determination of the area that mines should have according to scientific and equitable principles.

In the formation of a mining code to suit the conditions and exigencies of mining engineering, equity and value, various other considerations independent of *mere* law must be considered and applied, without which the area of a mine cannot be properly adjusted, and for this reason all the mining codes of South America, are imperfect simply because men of the law consider themselves capable of framing a code of legal previsions to regulate mining operations, without consulting mathematics and the science and practice of Mining Engineering.

The writer has always been of opinion that the law did not initiate or create the mining industry; but, on the contrary, theoretical and practical mining induced the law i. e., when mining had progressed and conflicts of possession and other disputed claims arose, third parties, such as arbiters were selected to determine such questions, but as these were not egally authorized, their descisions were, after a time, of no

effect, and hence arose the necessity for legal interference finally resulting in codes of regulations with power to enforce them.

Under the conditions existing to day in the mining world, it is impossible that the practice of the law, without the aid of that of mining engineering, is sufficient to determine the various dispositions necessary to form a modern code of mines.

For this reason any authorized commission undertaking the reformation of a mining code, must not only be composed of eminent men of the law, but veteran mining engineers also. The two sciences i. e., that of the Law, and that of Mine-engineering should then be blended together in such a manner that no conflict or contradiction in principles could exist. A code of mines compiled in any other form must, of necessity, be imperfect and inapplicable to the exigences of modern times.

One of the principal dispositions in any code of mines, is the question of the area of mines containing various classes of mineral, and for this reason the author has dwelt upon the details which should enter into this question at considerable length. Consequently, to fix an area for the concession of a mine which should contain, according to the best scientific engineering practice, just such a quantity of mineral, and no more than is sufficient to give an estimated or required extraction or produce per annum to continue for a determined period, having special reference to the cost of installation, exploitation future contingencies and other important questions, would, of necessity, involve very serious consideration and determination. Nevertheless, when it is necessary to form a new code of mines, or reform an old one so that it shall contain legal dispositions to meet all cases, real or imaginary, beforehand, it is absolutely necessary to invoke the best experience and methods for the formation of a legal scale de-

termining the area of mining concessions, and other dispositions, rejecting absolutely such antiquated modes as we have previously indicated and discussed.

Practical Mode of Determining the Area of a Gold Mine

For this object, it is necessary to determine the lenght of a mine containing a vein of an auriferous quartz-mining concession to be measured in the direction of or parallel to the line of out croppings of a mineral vein.

This determination will be based upon the following data, i. e., length of the mineral vein in the direction of the declivity as previously given in the table, or 231 metres; thickness of mineral vein, say 0·75 of a metre; working days 244 per annum; duraction of mine 23 years; extraction of mineral, 60 tons per day, specific gravity of the mineral 2·5, and weight per cubic foot 156 lbs.

Then $231 \times 0{\cdot}75 = 173{\cdot}25$ cubic metres, or 6,109 cubic feet, and $\frac{6{,}109 \times 156}{2{,}240} = 425$ tons.

This is the quantity of mineral existing in the mineral vein whose length measured in the direction of the declivity is 231 metres and one metre in length measured in the direction of the line of out-croppings of the mine.

Also, $\frac{240 \times 60 \times 23}{425} = 775$ metres, the lengh of the concession required under the conditions.

It is evident that by varying the data according to the conditions of the case, the length of mining concessions containing this or any other class of mineral may be determined.

Besides, if the mineral vein is thicker than that assigned, and is considered to hold gold throughout, the length of the mine determined in the same manner.

It is clear, therefore, that a definite lenght for a mine, irres-

pective of the thickness of the mineral vein, should not be admitted; but it should be made a conditional legal disposition, and the scale fixed in a code of mines should not only define the angles of declivity, but the thickness of the mineral vein with the corresponding length and widths for the concessions.

It is, therefore, conclusive that everything depends upon the thickness of the mineral vein, its productiveness and specific gravity of the mineral, all of which should enter into the question for solution.

In order to set this matter clear, another class of mine is adopted, i. e., a silver mine containing native silver, assaying from 0·6 to 0·80 °/₀.

In this case the specific gravity is taken at 3·5, giving 218.75 lbs per cubic foot. The thickness of the vein is the same as in the former case, the extraction 50 tons per day, the length of the mineral vein in the direction of its declivity under the angle of 30 degrees is 231 metres, and duration 23 years.

It is proposed to employ two *water jacket furnaces* reducing 25 tons of mineral, with 5 tons of fundents in 24 hours, or a total of 12000 tons per annum.

Then $231 \times 0{\cdot}75 = 173{\cdot}25$ cubic metres, or 6,109 cubic feet, and $6{,}109 \times 218 = 1{,}331{,}762$ lbs.

$$\text{also } \frac{1{,}331{,}762}{2240} = 594{\cdot}5 \text{ tons.}$$

Then $246 \times 240 \times 50 \times 23 = 276{,}000$ or the total quantity existing in the mine; from which we also have

$$\frac{276{,}000}{594{\cdot}5} = 464{\cdot}2 \text{ metres,}$$

or the length which the mine should have under the conditions given.

According to the same rule, a copper mine with a vein of

mineral 1·25 metres in thickness, specific gravity 4·45, with a daily extraction of 100 tons, and to continue for 23 years, would have a length of 349 metres.

A coal mine containing a bed of coal 4 feet in thickness, with a specific gravity of 1·3, and to continue for 23 years, with an extraction of 48000 tons per year, should have a length of 2983·7 metres.

An iron mining concession, with a vein of 1·25 metres in thickness, with a specific gravity of 4·9, continuing 23 years at an anual out put of 30,096 tons, or sufficient for two small blast furnaces, would require a length of 396·5 metres.

A Lead mine with a vein of mineral of 0·75 of a metre, yielding 23,040 tons per year, for a period of 23 years, would require an extension of 416 metres.

Determination of the Area required for a mining concession of Auriferous Deposits, such as Sand, Gravel and Consolidated Gravel.

In order to determine this question, it would be necessary to take into consideration the following items or elements in order to apply them in a practical manner.

DATA REQUIRED

1	Amount of capital required for installation	£ 20,000
2	Average thickness of auriferous deposit	2 metres
3	Annual expenditure for exploitation	£ 5,000
4	Average produce of the auriferous deposits in parts of an ounce	0·0520903
5	Annual benefit required upon capital	59 °/₀
6	Duration of the concession	10 years
7	Average price derived from the sale of gold per ounce	£ 3 10ˢ 0ᵈ

Then we have £ 20,000 × 59 °/₀ = £ 11,800 net to be produced, and, for the quantity of gold to be derived annually from the exploitation we also have.

$$\frac{£\,11{,}800 + £\,5000}{£\ 3{\cdot}5} = 4{,}800 \text{ ounces of gold}$$

which must be extracted from the auriferous deposit per annum.

Also, for the number of cubic metres which it is necessary to extract and treat per annum, we also have.

$$\frac{4800{\cdot}000000}{0{\cdot}052093} \times 1 \text{ year} = 92{,}142{\cdot}9 \text{ cubic metres.}$$

In this case, the concession must have a length of 92,142·9 metres by one metre of width, with a thickness of auriferous deposit of 1 metre, but in case the thickness is 2 metres, then the length would be

$$\frac{92{,}142{\cdot}9}{2} = 46{,}071{\cdot}45 \text{ metres.}$$

In the first case cited, if we fix the duration of the deposit at 10 years, quite a sufficient length of time, we should have.

92,142·9 × 10 = 921,428·983 square metres for the area, and in the second case 460,714·49 square metres for the area of the mining concession.

The topographical features of the places where the concession is required to be located may prevent the formation of a quadrilateral or other regular figure for its demarcation, but any irregular figure may be adopted which contains the area assigned.

It is highly probable that after a proper examination of the ground some of the data, referring to the average thickness of the auriferous deposit, and its capacity of yield may vary from what has been employed above, consequently the legal

authority, commissioned to set out the limits of a concession should possess the means of determining the facts upon the ground, and so adjust the area to the circumstances.

It is clear that a rich auriferous deposit could not be treated in the same manner as a poorer one in regard to the area, because such a course would be injurious.

When rich auriferous deposits were first discovered in Australia, the claim or concession allowed to each miner amounted to a superficial are of 144 square feet, but afterwards, when more formal exploitation of deeper deposits took place, greater areas were granted, but none of these were given according to any systematic plan.

Neither has the writer been able to discover that the area of any mining concession in the various countries of the world, have ever been made upon any mathematical and equitable system.

From the demonstration which we have made, it is evident that when the yield of auriferous deposits vary from 0·0260465 to 0·052093 of an ounce of gold per cubic metre, and the capital for the installation, annual exploitation, and the other conditions were as previously indicated, the area of 100,000 square metres, as is assigned in the mining code of the Republic is much too small, and unless there were a number of such concessions contiguous one to another, it is not probable that any formal company could be found in favourable conditions to exploit such a deposit or concession.

However, on the contrary, if the auriferous deposit were to be above the average rate given, and, in fact, on examination proved to be very rich 100,000 square metres would be in excess of the area needed, and injurious to the Sate.

Whenever, therefore, a new law is made it is absolutely necessary to change this diposition, and it would be convenient to define in it a minimum mining area, giving the commis-

sioned legal and technical mining authority the power to extend or diminish such an area according to the richness or poorness of the auriferous tract of land to be granted, taking into consideration, also, the required conditions and circumstances of the case, such, in fact, as those we have indicated in the previous discussion.

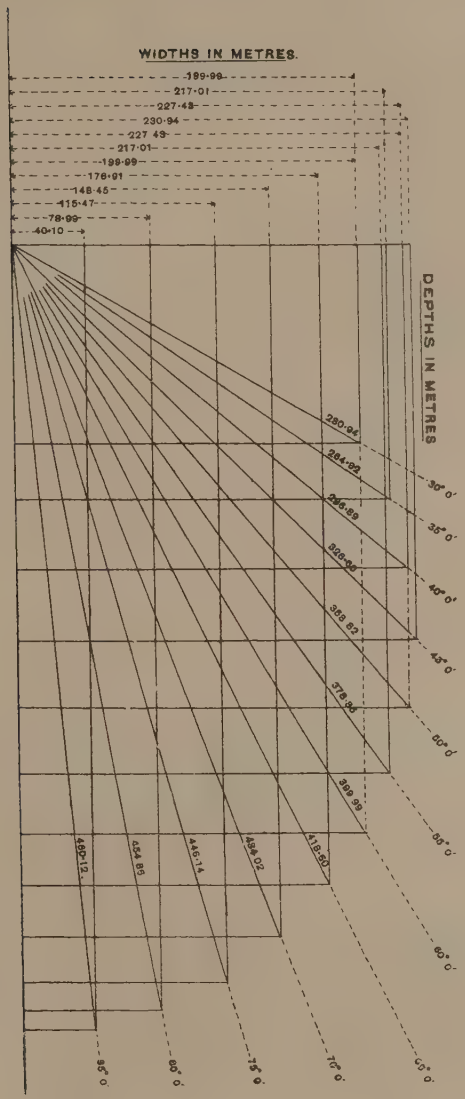
The following Table N.° 5, exhibits in column (2) the variation of cost of installation; the third, the thickness of auriferous deposits; the fourth, the percentage benefit to be derived; the fifth the estimated gross income; the sixth, the annual cost of exploitation; the seventh, the yield in parts of an ounce per cubic metre; the eighth the selling price; the minth, the area of the mine or the number of cubic metres exploited in one year, and column ten contains the total area of the mine and the number of cubic metres to be exploited during 10 years.

TABLE N.° 5

Unit of Duration of the Concession, 1 year.	Cost of Installation	Average Thickness of the Auriferous Deposit.	Percentage Required upon the Capital.	Estimated Gross Income.	Annual Cost of Exploitation.	Yield of Gold per Cubic Metre.	Selling price of Gold per ounce	Calculated Area of Concession for 1 Year's Working.	Calculated Area of Mining Concession Required for 10 Years Working.
Days	£	Metres	%	£	£	Ounces	£	Sq. Metres	Sq. Metres
240	20,000	1	59	11,800	5,000	·0520930	3·5	92,142·8983	921 428·983
240	20,000	2	59	11,800	5,000	·0520930	3·5	46,071·4492	460 714·492
240	10,000	1	59	5,900	5,000	·0520930	3·5	59,788·1762	597 831·762
240	10,000	2	59	5,900	5,000	·0520930	3·5	29,801·5881	298 915·881
240	10,000	1	59	5,900	5,000	·0260465	3·5	119,566·3794	1195 663·794
240	10,000	2	59	5,900	5,000	·0260465	3·5	59,783·1897	597 831·897
240	6,000	1	59	3,540	3,000	·0260465	3·5	71,739·8268	717 398·268
240	6,000	2	59	3,540	3,000	·0260465	3·5	35,869·9134	358 699·134
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

The writer has observed in another place that it would be excessively difficult to frame a project for the determination of the area which mining concessions should have according to the conditions laid down, or those required, which would be

FIG. 3


WIDTHS IN METRES.
199·99
217·01
227·43
230·94
227·43
217·01
199·99
176·91
148·45
115·47
78·99
40·10
DEPTHS IN METRES
30° 0'
35° 0'
40° 0'
45° 0'
50° 0'
55° 0'
60° 0'
65° 0'
70° 0'
75° 0'
80° 0'
85° 0'
230·94
264·92
296·89
326·60
369·82
378·96
399·99
418·50
434·02
446·14
454·86
460·12

absolutely free from objection, imperfection, and not liable to adverse criticism: nevertheless, it is submitted that the system now proposed-whatever value it may have—is, at least based upon well founded principles, and better adapted for the object under consideration than the antiquated methods which have been followed for so many years, and are now under consideration.

It will be observed that in the column (2) of Table N.° 4, the calculated lengths of the mineral veins increase in a regular manner, as they should do, according to the excess of depth, work and expense of installation and exploitation.

This is, also, graphically represented in Fig. 3, which gives all the calculated quantities contained in Table 4, and shows all the concessions which could exist under the scale of angles given. This figure forms a series of cross sections of mineral veins, including their depths and angles of declination. It is more uniform in character, and presents a more harmonious curve of work than exists under the antiquated scales.

Areas of Mines Allowed under the Present Code of Mines

Metalliferous mining concessions have a length upon the direction of the vein of 300 metres with a width according to the scale of angles of inclination, up to 300 metres, as follows.

	Square metres
Metalliferous mines	90,000
Coal mines and all combustibles . . .	270,000
Gold washings (placers)	100,000
Borax and other salts	1,000,000

These mines are conceded irrespective of the thickness and number of veins in each claim, but the law provides that a trial pit shall be made upon the vein so as to discover its amount of declination, and the maximum depth of the pit is 10 metres; and this pit is the legal point from which the mining concession is set out.

As previously remarked, the thickness of the vein has no legal bearing, still, it must be clear that a copper or silver vein *one metre* thick must have twice the value of anoter vein of the same class and yield, with a thickness of half a metre; but the difference would be enormous to the exploiter. In this way, concessions of mines are obtained with the thickness of a mineral vein having only a few centimetres, and although it may be worthless from a mining point of view, still it constitutes the right to a mining concession.

The law of mines, as it stands in the Argentine code, is of a protective nature and gives every facility to any person foreign or otherwise to obtain mining concessions, the chief conditions imposed being that the owner shall occupy the property with at least 4 workmen during 230 consecutive days in each year, but if this condition is not complied with the mine is forfeited to the State and may be denounced by a second party; but if the first owner can prove that his progress has been interrupted by what is termed *fuerza mayor* i. e., from causes beyond his control, then upon application to the mining authority he is permitted to suspend his workings for a period according to circumstances.

Those who have worked their mines for a consecutive period of 2 years, having employed capitals of consideration in machinery and exploitation, are permitted to suspend their workings for a period of 2 years, but the reasons must be justified in order to procure the legal permission.

The legal right to explore within a defined area which has

to be indicated to the mining authority, is granted upon petition, but such explorations extend only to 300 days, and the explorer has the prior right to obtain concessions upon all the mineral veins which he may have discovered in the area explored.

The code of mines is in force in all parts of the Republic, but the government of each province have the right to grant concessions of mines in its own jurisdiction according to the National legal dispositions.

The mines in the National Territories are granted by the National Government.

Congress, has the power to change the legal dispositions of the mining code when any project is submitted to it by the National Government for that object.

Commissions have been appointed to reform the present code of mines, but no practical result has yet been achieved.

Neither the National nor Provincial governments can take possession of and exploit mines for their own account, neither can they sell the mines to private or public companies without infringing, and, in fact, destroying the rights of the subject as originally conferred by the King of Spain.

CHAPTER XXV

Observations Upon Coal Deposits and Geology of the Republic

The important questions involved in the discovery of carboniferous deposits in the Republic under favourable conditions and of commercial value, such as would satisfy the future requirements of the country, without having to depend upon foreign countries, and the particular age of the rocky formations in which they exist, or may exist, have been subjected to much discussion and controversy. The geology of the country, also, has not escaped attention, but it would be impossible, in a brief notice of this kind, to indicate all the persons who have identified themselves in its study. It may, however, be remarked that this important science is taught and studied in the schools, the higher Colleges and Universities of the Republic.

Book learning and the theoretical principles to be taught and acquired from it, have, and will still prove of the greatest value and importance; but without the practical ability to read the leaves of the great book of nature presented in the rocky formation of this immense country, all the lessons in the world will be futile.

On the contrary, however, to the scientific and practical geologist, palæontologist and mining engineer, the case is vastly different, for they see, recognise, define and clearly read that which is presented to them in each page of the stupendous rocky book of God's creation, the glorious and imperishable characters, brilliant as the diamond, transmitting the sublime and fearful history of the creation, life and death of all those worlds of various organic forms, the existence of which has been preserved as fossil remains in an evident and palpable manner throughout the lapse of the obscure and mysterious periods of the past, the duration of which can only be compared to the eternity of the future, the sublimity of which transcends the capacity of the human mind.

It must, therefore, be evident that a mere study of geology, without the aid of the sister science Palæontology, cannot be otherwise than imperfect and lessened in value.

From what precedes, it may be deduced that Palæontology is a science as profound in its bearings as it is beautiful, interesting, useful and important. To repeat, it must, therefore, in all truth be considered as the twin sister of geology and, consequently, marches hand in hand with it, illuminating the intelligence and dissipating the dense obscurity surrounding the great and mysterious truths of Nature's secrets.

It is not generally understood or acknonledged in this country, that the connection between geological studies in the field and mine engineering are very closely allied, but it is, nevertheless true, for, whilst the former science is accepted as being sufficient to explain the mode of occurrence, age and changes which the different formations have undergone, it is also, in some measure, an index to the nature and importance of mineral deposits. However, the latter exhibits the still more important question referring to the extension, composition, proper and economical modes of exploitation, and determi-

ning the commercial value of each class of mineral discovered.

Probably, therefore, no apology is needed for the introduction of these remarks in this place.

For a considerable time prior to 1863, the so called coal deposits were known to exist in a place called *Marayes*, in the district of La Huerta, province of San Juan, and about that time Mr. Rickard, the engineer appointed to examine the mines of the Republic, directed his attention to this carboniferous deposit, and he found outcroppings of beds of this substance which extended for a distance of nearly three miles, but of such a poor quality that he doubted whether it would have any commercial value. The coal, according to him, contained 25 °/₀ of ash. At this time it does not appear that any workings had been placed in the coal beds; but, in 1870, some proof of the nature of these beds of carbonaceous deposits had been made, and this induced the same gentleman, Mr. Rickard, to form a different opinion, for he stated. "The coal extracted from the Marayes is of a good quality, and the deposits, as far as they can be traced, have a considerable extension, over an area of several leagues".

The discovery of coal in the Republic at that period was considered to be of great importance, and after various representations the Honourable Congress of the Nation passed a Law, N.º 8189, in October 1870, offering a premium of $ 25,000 for the discovery of a coal mine in the Republic in such conditions as would permit of a beneficial exploitation for industrial purposes, and which could be compared to and compete with foreign coal.

This disposition of Law was intended to encourage and incite formal investigation, and a final discovery of an abundance of coal of good quality, for the then and future industrial uses as, also, that such discoveries would lead to and induce the expenditure of capital in the development of such coal deposits.

The spirit of that Law was plain and effective, and to a certain degree had the desired effect.

One of the principal pioneers and most indefatigable workers in this sense and cause was the late Mr. F. S. Klappenbach, who devoted much time and capital in perforation works which he carried on in 1871, with the object of proving the carbonaceous deposits in the *Marayes* province of San Juan.

The coal which he extracted gave by analysis the following elements.

Fixed carbon.	46·00 %
Volatile matter	43·96
Ash	10·00
	99·96

with a calorific force of 5711: it was classified as a lignite.

Coal in no better condition than that represented in the above analysis, has been worked in other countries where a better class of fuel is scarce; but, in that case, the beds are thick, but those discovered by Mr. Klappenbach, on the contrary, were not proved to be in a condition to be exploited to a profit.

This gentleman had his mines examined by some engineers, and he published their reports, in which occur a series of vertical sections of the strata and coal beds passed through. These the writer also published in 1889 in his larger work upon the mines of the Republic.

In 1876, Mr. Ricardo Napp made a reference to the coal basin in the province of San Juan, and speaks of the carboniferous formation as belonging to the geological period known as *Rhætic*, derived no doubt from the engineer's report published by Mr. Klappenbach.

Also, in 1876, the great naturalist, the late Doctor Burmeister, published the results of the study which be made of the bituminous deposits of the Marayes, and also of some others near to Uspallata, province of Mendoza; but he has not given any demonstration that such deposits belong to the same period as the great coal deposits of Europe.

In 1877, Mr. Estanislao de la Reta, manifested that he had discovered a coal deposit at a place near to Retamito, in the province of Mendoza, and he obtained a commission of engineers to study the coal deposits.

In the report the commission gave the following analysis.

Fixed carbon	34·45 °/₀
Volatile matter, etc . . .	19·20 "
Ash	35·82 "
Water.	10·00 "
	99·47 °/₀

In 1886, the writer and the first Mining Engineer of the National Government, Mr. Carlos A. Lynes Hoskold, were commissioned to make a study of the carboniferous formations and places where artesian wells might be made in the province of Mendoza, the exploration, for some curious reason or another, being confined to a certain defined area, and after devoting a considerable amount of time to this question, nothing more than thin beds of bituminous schist were found.

Some of these worthless deposits were situated in the Valley of Papagallos and other places within the area indicated.

Outside the limits assigned in the instructions, the examination was extended to the coal deposits said to have been discovered by Mr. E. de la Reta, as, also, the neighbourhood of Challao, but the writer did not find any evidence of the

existence of coal beds of commercial value, and belonging to the great carboniferous period. He, however, made a collection of fossils too numerous to be enumerated in this notice, although some of the more important ones will be referred to further on.

The late Mr. Klappenbach, the gentleman previously referred to, again attempted to explore the bituminous deposits of Marayes in 1887, and obtained results which he considered to be satisfactory.

Previous to 1886, a coal deposit was reported to exist at Paganzo in the province of La Rioja, and in that year concessions were obtained and located upon these bituminous lands. It seems that the late Doctor Brackenbusch, the then professor of Mineralogy and Geology in the University of Cordoba, had examined this locality and formed a favourable opinion of the coal beds which he said existed there. This opinion was considered to be alsolute, and one of the interested parties, the late Mr. Rafael Igarzabal, one of the Senators of the Nation applied to the National Government for the premium of $ 25,000 for the discovery of coal at Paganzo.

This application occasioned the appointment of a technical Commission, consisting of Doctors J. J. J. Kyle, Puiggari, Carlos Berg, Anacleto Gil, and the writer as president.

Consequent upon a legal circular issued by the Commission, other applicants presented themselves as discoverers of coal, and entitled to the premium of $ 25,000.

At the commencement of 1887, the Commission was inundated with documents and conflicting statements; and after devoting the greatest attention to the claims from a legal and equitable point of view for a period of 13 months, it arrived at the conclusion that only a single applicant i. e., the Paganzo Company had complied with the established conditions.

The commission possessed no legal power or attributions to

inspect, or order an inspection to be made of the different places where coal was said to exist, its action being confined to the documentary evidence produced, and the quality of the samples of coal presented. Doctor Brackenbusch presented an extensive report in which he said "Here is the coal, Mr. Igarzabal, and it is rich, abundant and only thirty kilometres from the station of Los Colorados, on the railway from Dean Funes to Chilecito, which will soon be commenced". This informe was dated 16 April 1886.

Now, without a practical examination of this coal deposit by practical mining engineers, the Commission had to accept the opinion of Doctor Brackenbusch; but considering that it was composed of scientific and practical persons, a certain doubt was entertained, and, consequently, the Commission recommended in its very elaborate report that before granting the premium for the indicated discovery of coal, the Company should prove the opinion of Doctor Brackenbusch by making perforations at Paganzo.

The report of the Commission was extensive and exhaustive, and was presented to the Minister of Interior in 1887.

Two classes of coal was presented to the commision, one a bituminous schist, and the other a good quality lignite. The last was analysed by Doctor Puiggari on the 30th. November 1886 with the following results.

		Per cent
Water		7·38
Carbon	65·34	= 70·08
Coke ash	4·74	
Combustible gases		22·54
		100·00
Calorific power		3991· —

Some other samples of the same class of liguite were also presented to the commission, analysis of which gave the following results.

	Per cent	Per cent
Water.	8·85	7·38
Carbon	65·30	65·34
Ash	1·70	4·74
Volatile matter. . . .	24·15	22·54
	100·00	100·00

It was not, however, anticipated that lignite of this quality would be found in large masses, and afterwards, and upon a proper investigation, this opinion was substantiated.

The same company i. e., that of Paganza, presented samples of bituminous shale, and, these, also, were subjected to a series of analysis with the following results.

	Per cent	Per cent	Per cent	Per cent
Water.	1·00	2·00	2·00	1·882
Carbon	18·24	31·00	30·90	41·562
Ash	32·58	36·64	37·00	31·640
Volatile mather. . . .	48·18	30·36	30·10	24·916
	100·00	100·00	100·00	100·00

The government acted upon the advice of the commission and, consequently, the Paganzo coal company introduced into the country an expensive Diamond Drill or perforating machine from the United States of North America, and, also, a practical mechanic to conduct the perforations. Doctor Brackenbusch had already conducted the sinking of a pit close to the base of a granite hill, which was called after his name, and he was employed by the company to indicate where the

new perforations should be made. The first was commenced in 1888, at a point 50 metres distant from the pit Brackenbusch, and was continued to a depth of 80 metres passing through thin beds of clay, sandstone and shales. At the depth mentioned the granitic rock was encountered.

At a distance of 50 metres in a direct line from the first perforation, a second was commenced, and after passing through a series of sandstone beds, volcanic rocks and shale, it struck what is termed coal-partings of 4·5 inches thick at a depth of 163 metres, terminating in sandstone rock at 172 metres. A third point was selected at a distance of 100 metres in a direct line from the perforation N.º 2, and after passing through a series of strata similar to those in N.º 2 perforation, a granitic bed was struck at a depth of 236 metres. It was continued in massive red sandstone to a depth of 293 metres and then ceased.

Thus the written statements of Doctor Brackenbusch which had cost the Nation so much labour, and the Paganzo Company the loss of much capital, were not substantiated and the premium was not granted.

The writer constructed a geological section 3·5 metres in length, in colours, of the strata passed through by the perforations made at Paganzo, at his own cost, and at the Exhibition of Chicago, in 1893, the Jury of Awards considered it to be artistically drawn and of value and, consequently, awarded the highest prize for it.

The following details of the rocks passed through are taken from the section in question, which is still in the possession of the writer.

Section N.° 1 of The Perforation Made in 1888, 50 yards West of The Brackenbusch Shaft.

DESCRIPTION OF THE ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet	DESCRIPTION OF THE ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet
Gravel	11	11	Slate	2	108
Drift	22	33	Sandstone	5	113
White sandstone	4	37	Slate	1	114
Soft shale	3	40	Sandstone	9	123
Red shale	4	44	Sand shale	7	130
White soft shale	3	47	Sandstone	5	135
Clay shale	4	51	Sand shale	4	139
Sand shale	11	67	Slate	2	141
Clay shale	5	67	Sandstone	10	151
Sand shale	10	77	Sand shale	6	157
Sandstone	6	83	Slate	4	161
Slate	2	85	Sandstone (conglomerate)	24	185
Shale	2	87	Sandstone (red rock)	16	201
Soapstone	3	90	Sand shale	7	208
Sandshale	3	93	Sandstone	6	214
Soap stone	4	97	Shale	6	220
Sandshale	5	102	Red sandstone	30	250
Sandstone	4	106	Granite	10	260

The details of section N.° 2 of the perforation, made also in 1888, at a distance of 50 metres in a direct line to the west of N.° 1 boring, last described, are as follows.

DESCRIPTION OF ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet	DESCRIPTION OF ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet
Gravel	13	13	Slate	2	375
Red sandstone	47	60	Sandstone (conglomerate)	3	378
Red paint rock	3	63	Black slate	4	382
Red sandstone	7	70	Sandstone (conglomerate)	12	394
Red paint rock	16	86	Soft shale	6	400
Red sandstone	12	98	Sandstone	10	410
Red paint rock	12	110	Slate	4	414
White sandstone	2	112	Conglomerate	7	421
Red sandstone	8	120	Sandstone	13	434
Red paint rock	4	124	White sandstone	4	438
Red sandstone	14	138	Slate	3	441
Red paint rock	5	143	White sandstone	5	446
Red sandstone	10	153	Soap stone	4	450
Red sand shale	29	182	Sandstone	36	486
Red sandstone	20	202	Slate	2	488
Red volcanic rock	85	287	Sandstone	18	506
Volcanic rock	20	307	Slate	2	508
Volcanic rock (light colour)	6	313	Sandstone	21	529
Black slate	18	321	*Coal partings* (slate white)	4	533
Brown slate	17	338	Cap rock	2	535
Sand shale	6	341	*Coal partings* (slate white)	4	539
Black slate	4	348	Sandstone	7	546
Sandstone	12	360	*Coal partings* (slate white)	3	549
Sandstone (conglomerate)	13	373	Sandstone	6	555

Also, the details of section N.° 3 of the perforation made in the same year and at a distance of 100 metres to the west from N.° 2 boring, just described, are as follows.

DESCRIPTION OF ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet	DESCRIPTION OF ROCKS	Thickness of the Rocks in Feet	Depth from surface in Feet
Doby	18	18	Red slate	7	720
Gravel	23	41	Red shale	65	784
Red sandstone	389	430	Red granite	4	789
Red slate	226	656	Blue shale	1	790
Red sandstone	10	666	Red sandstone	10	800
Red slate	7	673	Red shale	8	808
Shale	40	713	Red sandstone	150	958

The proofs which Mr. Klappenbach had made upon the carbonaceous deposits in the Marayes, did not seem to be sufficient to convince people of the real condition of these bituminous beds, and, for that reason we find that in 1887, a Mr. Juan Cruvillier formed a society to exploit the beds which he urged existed in the Marayes, or Himanas as be termed the place.

It appears that three pits were made, a section of one of which appeared in a report dated 1889, and had a depth of 56·70 metres. A number of coal beds are shown in this section, and, although a large sample of the coal from one of the pits was exhibited for some time in the offices of the Stock Exchange here, (Buenos Aires) still it did not induce a formal exploitation of the coal mines of the Himanas. This large sample of bituminous matter came into the hands of the writer and measured 4 superficial feet and about $2\,^1/_2$ inches in thickness.

It was exhibited by the writer at the Chicago Exhibition, in 1893; but the member of the Jury who examined it, considered that it was not sufficiently important to receive a premium.

According to the late doctor Burmeister, the rocks on the south side of the Sierra de la Huerta, belong to the *Tertiary*

period, and that from this extreme point of the Sierra, along the eastern base passing the Papagayos, the Huerta, Chucuna to Astica, the same formation may be traced.

According to this authority, five veins of carbon exist from the place called Papagayos to the South of La Huerta, which appear to have an average direction of North-east to South-west. Nevertheless, it appeared on the ground in a curved form from the Marayes to the Huerta.

According to the opinion of doctor Burmeister, the thin beds are found in metamorphic rocks, and, consequently are no longer in contact with the *Tertiary formation* which passes below, and he describes the Sierra de la Huerta to consist of metamorphic rocks extending toward the north in a broken chain up to the Valley Fertil, Iglesia, Salinitas, Bichigasta, etc. and to the Cerro of Famatina.

However, doctor Steltzner has expressed a different opinion, and stated that the southern part of the sierra of the Huerta consists of sandstone rocks belonling to the *Rhætic formation*, and that they extend up to the Papagayos, Marayes, Huerta, Barrancas, Colorado and further towards the north or, at least, within two leagues of Tucuna on the eastern slope of the Sierra and, also, for about 3 leagues to the north of the Chacrita.

The same author stated that towards the extreme north the *Rhætic* formation is joined to that of the gneiss mountains which penetrate various leagues towards the south between Marayes and Papagayos forming the central part of the *Cerro*, and that the eastern and western sides are surrounded by the *Rhætic* formation. This authority thought that a carboniferous deposit existed, and not a mere deposit of bituminous schist.

This same geologist also stated that another portion of the *Rhætic* formation existed towards the north commencing in or to the east of Salinitas, and, also, that, at a distance of 7

leagues from the last mentioned place there exists large beds of sandstone which also belongs to the *Rhætic formation.*

A similar formation is also found at Jachal, Guaco, and in various other places to the south of Jachal. In Tambillos, in the province of Rioja, are to be found other parts of the same class of rocks which appear to indicate the presence of carbon.

The same author has classified all the rocks of the province of Mendoza, in which carbon is found, as belonging to the same period, i. e., the *Rhætic formation.*

The late doctor Brackenbusch also stated that the deposits of carbon discovered by him at Paganzo, in the province of La Rioja, existed in the *Rhætic,* and that some of the veins or beds of carbon rested immediately upon granite rocks.

So that useful data may not be lost, the writer has transcribed the followings elements contained in the following tables from one of his former works now out of print.

N.° 1

DATE 1887	State of the retort	Duration of charge	Gas per 1000 kilos of coal	Coke per 1000 kilos of coal	Illuminating capacity
			Cubic metres	Kilos	Candles
June 7	Red	70 minutes	270·2	680	14·92
»	Bright color	52 »	275·2	651	14·63
»	»	52 »	275·8	690	14·74
		Average	273·73	673'66	14·74

N.° 2

June 10	Red	57 minutes	204·4	707	19·81
»	Bright color	60 »	208·6	722	18·49
»	»	58 »	204·4	727	18·85
		Average	205·8	717	19·06

The above table N.° 1, exhibits the quantity of gas, coke and illuminating capacity of the carbon which was obtained from the mines of the late Mr. Klappenbach, situated in the Marayes, province of San Juan.

In table N.° 2, are also represented the elements obtained from the carbonaceous matter which was said to have been extracted from the mines of the late Mr. R. Igarzabal, at Paganzo in the province of La Rioja.

These determinationes were made by Mr. Stevenson, the manager at that time of the gas works at Barracas, Buenos Aires, and he was of opinion that the carbon of Marayes appeared to have all the properties of European coal, producing a regular quantity of gas with a great illuminating force, equal to that obtained from the Newcastle coal; but that the coke was soft and dirty, and was of no use for heating purposes.

A comparison of the elements of tables N.° 1 and 2, shows that the carbonaceous material obtained, or said to have been obtained from the Paganzo mines, gave 205·8 cubic metres of gas per french ton, or 67·93 cubic metres less than that produced by the carbonaceous matter obtained, or said to have been obtained from the Marayes; but the former yielded 45 kilos more coke and 4·30 more candle force than the latter.

For many years past carbon has been discovered and reported at a place called Tambillos, in the province of La Rioja, and other places, but its commercial value has not been proved up to the present.

Various geologists and others had also reported carboniferous deposits in some of the mountains near to Famatina; but after an examination of these gas shales, "The Famatina Development Corporation" refused to take up concessions which had been located upon the carbonaceous shales.

Various samples of this bituminous shale have been examined by the writer, and from analysis made of it, he has selected the following as typical.

Fixed carbon.	8·10 °/₀
Volatile matter	10·20 "
Ash	79·91 "
Water	1·79 "
	100·00 °/₀

Besides the well known deposits of coal in the Department of San Rafael, belonging to Doctor Salas, and the bituminous desposits of Mr. E. de la Reta, there are other deposits of lignite and bituminous substances in the province of Mendoza, but of these the writer does not possess any reliable analysis, and for this reason a description cannot be given.

Considering, however, that the coal question is of the greatest importance and that, consequently, this chapter is intended to convey all that is of practical value referring to it, the writer has, at the risk of being criticised as a *tautologist*, incorporated the analysis given in former chapters upon coal together with all the others which he considers to be of the most reliable and practical importance.

The coal deposits of Doctor Salas, situated in the Department of San Rafael, province of Mendoza, have been referred to in chapter X, p. p. 239, 243. The analysis occurring on p. p. 241, 242 are repeated here as follows:

Fixed carbon.	47·61 °/₀
Gases and volatile matter .	49·51 "
Water	2·05 "
Ash	0·63 "
	100·00 °/₀

After evaporating the water and eliminating the ash, another analysis gave:

Hydrogen.	8·63 %
Oxygen	25·12 "
Carbon	60·59 "
Nitrogen	1·43 "
Sulphur	4·23 "
	100·00 %

It was found that an average sample of the coal had a specific gravity of 1·173, and heating power of 5485.

The following analysis of the coal obtained from the mines of Doctor Salas were made by Doctor Pedro N. Arata.

Inmediate Analysis

Water	2·35 %
Ash	0·48 "
Coke	49·43 "
Volatile matter	48·21 "

Heating power 5809·32.

Elementary Analysis

Carbon.	81·37 %
Hydrogen.	6·85 "
Oxygen	11·19 "
Ash	0·59 "
	100·00 %

Other analysis of the same class of coal, obtained from the coal mines "*General Mitre*" and "*General Roca*", belonging also, to Doctor Salas are as follows:

Humidity		4·250 °/₀	2·260 °/₀
Volatile matter		43·700 "	41·720 "
Fixed carbon 51·330	coke.	52·050 "	56·020 "
Ash . . . 0·720			
		100·000 °/₀	100·000 °/₀
Heating power.		5573·159 °/₀	6075·920 °/₀

This coal was proved in the Primitive Gas Company of Buenos Aires with the following results.

Coke produced	40·00 °/₀
Gas	38·00 "

Illuminating power from 24·37 to 27·30 candles, and the report stated that the coke is light but very pure and that the coal is of a superior quality for the production of gas. This report is dated 28 August 1892.

Various samples of coal, or at least of a bituminous substance, were sent to the National Department of Mines and Geology, and in some cases, the name of the mines or deposits from which they were derived, were not stated. One of these samples is described as having been obtained from a mine situated at a distance of two leagues from the city of Mendoza. The analysis of the sample is as follows.

Fixed carbon	25·24 °/₀
Volatile matter	17·82 "
Ash	55·52 "
Water	1·42 "
	100·00 °/₀

The specific gravity amounted to 1·56.

Another sample was described as comming from *Cacheuta*, province of Mendoza, and its analysis was as follows.

Fixed carbon.	36·38 °/₀
Volatile matter	
Ash.	60·00
Water	5·62
	100·00

A sample of coal from one of the bituminous schist mines of Mr. E. de la Reta, situated in the same province gave the following analysis.

Fixed carbon.	34·48 °/₀
Volatile matter	19·20 "
Ash	35·82 "
Water	10·50 "
	100·00 °/₀

For a very particular analysis carried out for the discovery of *Vanadic Acid* in the ash of this coal, the reader is referred to page 242.

Referring to the nature and age of the rocks existing in a part of the province of Mendoza, the late Doctor Burmeister expressed the opinion that the mountains situated to the west of Mendoza consisted of sedimentary beds belonging to the *Palæozoic* period, and containing a carboniferous formation, nevertheless, he added that this formation is not in the true coal measures known to exist in Europe and other places, i. e., between the *Devonian* and *New Red* sandstone formations.

The Doctor also discovered in the locality of Challao some plants of the fern family, which had no distinctive form.

Challao is situated at about 1 ½ leagues to the south west of the City of Mendoza, and when the writer inspected it, he made excavations upon certain bituminous schist beds, not at all approaching to coal, as had been represented. The

bed of dark schist had a direction of N. 30° E., inclining 60 degrees to the north at an angle of 50 degrees. There existed in the overlaying brown beds an immense quantity of fossil plants badly preserved and, consequently, their class could not be determined nor, by their means, the age of the rocks-inclosing them.

The bituminous schist, called coal, situated between San Isidro and Crucecita, or in the valley of Papagayos, was found to be in the same rotten condition, and although it contained numerous fossils, still none could be obtained.

However, in an underlying thin bed of grey limestone at some distance from the bed of dark bituminous schist, the writer discovered a variety of fossil plants in an indifferently preserved condition, and among these he recognised *Pecopteris* and *Neuropteris*, of the long family of ferns, as also an isolated example of *Glossopteris browniana*, which the writer believes has not been previously described in this Republic. This fossil plant is similar to *Naggerathia obovata* discovered in the carboniferous period of Rio Grande do Sul, Brazil in 1869. The writer also discovered the genius *Phyllotheca* in another place in this province.

Also, in the neighbourhood of Challao, in a dark rotten bed of slate, he discovered various *Graptoliti* representing *Phyllograptus, Diplograptus* and *Climacograptus* associated with *Diplograptus*.

This discovery proves to a demonstration that the rocks in which these fossils occurred belong to the lower part of the *great silurian formation*, and proves that Doctor Burmeister was right when be stated that the Palæozoic period of rocks existed in some parts of the province of Mendoza.

The collection of fossils which the writer made was sufficiently extensive, but they did not prove the presence of the great carboniferous period.

It has been stated that coal existed to the south west of Mendoza, near to Lujan, but it has not, to the knowledge of the writer, been determined whether it consists of black bituminous shale or otherwise. Also, it is stated that in the plain of Uspallata, between Paramillo and the Cordillera of the Tigre, carbon has been found.

The late Doctor Burmeister had arrived at the opinion that these deposits of carbon are, towards the south, in contact with volcanic rocks and that, towards the north, the rocks belong to the primitive series, that is to say Silurian.

Near to the same locality, the well known geologist Steltzner, has shown that there exist beds of *Carboniferous strata* deposited upon sandstone beds belonging to the Rhætic formation, in the *Mesozoic* in contact with *Silurian* rocks towards the south, and with *Andesite* and other undetermined formations towards the north.

Considering that no particular and precise engineering geological survey has yet been made determining in an absolute manner the quality and limits of all these formations, it is not possible to define at present the limits of any bituminous deposits which may exist in the provinces of San Juan and Mendoza. Probably, however, soon we shall be able to direct more particular attention to these questions.

For many years past it was known that coal deposits existed in the National Territory of Neuquen, a description of which, with its various kinds of mines have already been given in Chapter XVIII.

The analysis of this coal given in that chapter is repeated as follows.

Fixed carbon. . .	53·90	50·18
Volatile matter . .	33·50	35·42
Ash.	3·55	10·65
Water	9·05	3·75
	100·00	100·00
Coke	57·46	61·13
Ash contained . .	6·26	17·30
Heating power . .	4570	4636

Various other analysis have been made of this coal, the following having been selected from them.

Fixed carbon .	72·18	53·76	63·32	58·91
Volatile matter.	26·68	31·05	35·62	35·72
Ash	0·72	14·65	0·28·	3.22
Water. . . .	0·52	0·55	0·78	3·15
	100·00	100·00	100·00	100·00
Heating power	5585·43	4384·35	5163·6	4804·0

Clearly, therefore, we have two classes of coal in the Territory of Neuquen, one of which contains more ash than the other.

Carboniferous deposits have also been discovered for a considerable time past in the National Territory of Chubut, and of the samples that were exhibited in the National Department of Mines and Geology, some were analyzed.

The following is an example.

Fixed carbon	41·00 °/₀
Volatile matter.	39·00 "
Ash.	9·00 "
Water.	10·00 "
	99·00 °/₀
Coke	49·00 °/₀
Heating power.	4219 °/₀

This coal was very compact and hard, capable of being transported without falling to pieces.

In 1894, the existence of coal was proved in the National Territory of Rio Negro, and according to the official analysis, ordered by the writer, the elements were as follows.

Fixed carbon.	35·20 °/₀
Volatile matter	27·75 "
Ash	34·60 "
Water	2·45 "
	100·00 °/₀
Coke.	69·54 °/₀
Heating power	4197 °/₀

The late Coronel Rhode believed that he had discovered a coal mine in the Territory of Rio Negro, and made application for a concession but did not fulfil the conditions of the law. The Samples of coal which he appears to have extracted were analyzed and a copy of the same was as follows.

Fixed carbon	64·07 °/₀
Volatile matter	25·94 "
Ash.	8·14 "
Water	1·85 "
	100·00

The sample of coal which Coronel Rhode presented for the inspection of the writer appeared to be compact and hard, but no information was presented referring to the thickness of the coal bed, but it was stated that the coal extended over a arge area.

Another deposit of coal also seems to have been discovered somewhere along the banks of the Limay river: but whether in the National Territory of Neuquen or that of Rio Negro

is uncertain, for, the parties who made the discovery were reluctant to give information as to the precise locality. However, they possessed a large sample of the coal which the writer inspected, and from its general physical appearance he was led to believe that it was of an excellent quality. It was very compact and hard but, unfortunately, no analysis was made of it, at least, if it were, it did not reach the writer. It was, however, stated that the out-croppings of this coal formation could be traced upon the surface for a long distance.

The late Mr. Thomas Kincaid, in association with an *estanciero* in the Territory of Santa Cruz, made a formal application for a coal mine near to the Bay of San Julian, but did not continue the legal procedure.

This carboniferous deposit had been known for many years; but the writer does not possess any information as to the thickness of the formation or any analysis of the coal.

The so-called deposits of lignite along the southern coast of the National Territory of Tierra del Fuego, were known many years prior to 1895, but in that year petitions were newly made for this combustible, a history of which, and the interest the government was induced to take in investigating the importance of the deposits, has already been given in Chapter XXII, pp. 347, 348. However, as previously noted and in order to bring all the analysis of carbon into one chapter, the analysis on page 348 is repeated in this place:

Fixed carbon	42·44
Volatile matter	40·72
Ash	0·84
Water	16·00
	100·00

Another analysis of the same lignite gave the following results.

Fixed carbon.	39·59
Volatile gases.	34·36
Ash	5·31
Water	20·74
	100·00

The Union Industrial Club also made other analysis of the same class of lignite, with the following results:

Water	26·850	17·00
Volatile matter . . .	31·630	31·88
Fixed carbon	39·470	18·40
Ash	2·050	32·72
Sulphur	0·466	*not determined.*
Heating power . . .	3482	2324

The lignite contained a considerable amount of oxide of iron, but the per centage of this element was not determined. However, it has the effect of causing it to fall to pieces when exposed to atmospheric action.

A few years since lignite of a superior quality was discovered in the Province of Salta, and samples of it were presented to the Department of Mines and Geology and it was tested in the laboratory. Doctor Kyle was also good enough to make an analysis of it and found it to contain the following elements:

Fixed carbon.	51·38 %
Volatile gases.	44·85 "
Ash	3·22 "
Water	0·55 "
	100·00
Coke	55·60
Heating power	5600

Curious enough Doctor Kyle also found that the ash of this lignite contained *Vanadic Acid* similar to the coal of San Rafael, province of Mendoza, and that of Neuquen.

The existence of this lignite deposit of Salta was first known in Buenos Aires in 1895.

A large number of samples of carbon from different parts have been sent to Doctor Kyle for analysis, and he was good enough to present to the writer the following table of the elements which he obtained. These determinations are of the greatest value and importance as coming from the most reliable authority.

Table of Analysis of Argentine Coal

PROVINCE OR NATIONAL TERRITORY	CLASSIFICATION	Heating power	Density	Higroscopic Water	Volatile matter	Fixed carbon	Ash
Rioja (Paganzo)	Bituminous	3572	1·582	2·00	30·10	30·90	37·00
"	Lignite	6054	1·313	8·55	24·45	65·30	1·70
"		6274	?	0·90	21·16	72·44	5·50
Mendoza	Lignite	3043	?	10·50	10·20	34·38	35·82
"	"	3356	?	14·05	21·55	41·20	20·20
"	"	3958	1·430	12·90	20·65	37·09	29·36
"	?	4402	?	1·50	27·70	40·95	29·85
"	"	4997	?	1·60	28·85	41·03	28·52
"	—	4558	?	2·05	31·33	43·95	22·67
"	—	4600	?	2·65	25·97	38·68	32·70
" (Uspallata)	?	4102	?	1·60	24·72	41·93	31·75
" "	Coke	5011	?	0·60	1·25	58·75	39·40
" "	Vanadifere	5364	?	0·55	46·10	50·30	3·00
" (Las Higueras)	Lignite	4031	?	10·65	27·41	42·64	19·50
" "	"	5167	?	8·40	32·80	52·95	5·85
" "	Dry coal	3936	?	5·65	25·75	38·20	30·40
Neuquen	?	4571	?	9·05	33·50	53·90	3·55
"	"	4636	?	3·75	35·12	50·48	10·65
"	Vanadic	5420	?	0·50	30·40	67·40	1·70
"	"	4652	?	2·50	38·20	52·45	6·85
San Juan	?	5082	1·550	1·50	30·80	43·15	21·55
" (Las Himanas)	?			1·46	25 02	63·52	10·00
" "	?	5090	?	1·30	35·07	47·17	16·46
" (Colorado de Gonda)	?	5174	?	3·15	22·15	49·97	24·73
Tierra del Fuego	Lignite	3854	1·420	16·52	32·10	31·74	16·66
"	"	3767	1·460	23·40	36·20	28·74	11·64
Chubut	"	4219	?	10·90	39·00	41·00	9·10
Salta	?	3703	?	16·50	40·72	37·68	5·10
"	Lignite	3351	?	21·75	37·26	53·87	7·62
Jujuy	"	3065	?	21·25	29·05	32·72	16·98
Catamarca	?	5993	?	1·55	33 05	62 88	2·52

In 1891, the late Doctor Carlos Berg, at that time Director of the Museum of Natural History in Montevideo, and afterwards Director of the National Museum of Natural History of Buenos Aires, wrote a pamphlet of four pages, and published it in the *Anales* of the *Sociedad Cientifica Argentina*, with two objects, i e; to prove the existence of the carboniferous formation in the Republic and the discoverer of that formation. He cites the opinion of Doctor Sajnocha, a celebrated Paleontologist who, when referring to some correspondence said "The vegetable remains last sent to me—from the Argentine Republic—have again confirmed my former determinations as to their age. I have been able to determine five species as belonging to the lower coal (kulm inferior). They are *Archaeocalamites radiatus* Brognt, (very abundant and in various samples of different age), *Lepidodendron*, of the group of the *L. nothum* Unger, *Lepidodendron Pedroanum* Carruthers (3 samples), a doubtful *Rhaeopteris, Machanestri*, Stur, and *Cordaites borassifolius* Brognt (2 samples)". "The two samples are of the *trias superior*,—and not from the *tertiary* as is the opinion of Mr. Meister—from the Huerta de Marayes, with impressions of *Thinnfeldia, odontopteroides* and badly preserved specimens of *Pterophyllum longifolium*.

These supra-triasic vegetable remains have already been mentioned in my work upon the plants of Cacheuta—province of Mendoza—and Steltzner and Geinitz knew the locality of La Huerta of Marayes.

It seems that Prof. Szajnocha had occasion to communicate his fossil determinations of the Retamito to Doctor Brackenbusch, and that the latter stated that he considered the carboniferous deposit at that place—Retamito—as a mistification, and that the vegetable fossil remains had been carried to and deposited there by some artificial means." However, this opinion was not acceptable and other persons had opposite ideas

considering the coal deposit at Retamito as belonging to the true carboniferous formation.

As far back as 1888, Doctor Brackenbusch visited the carbon mines situated near to the river Pedernal, close to Retamito, and he says that "having excavated some 6 metres in a sort of adit, he found some coal mixed with ferruginous matter; also that the rocks consisted of grey standstone and slate resting indirectly upon *Silurian limestone* which forms the Sierra del Pedernal".

It would also seem that Doctor Brachenbusch was made to say that he had found the fossils *Archaeocalamites radiatus*, (BRGT.) STUR, *Lepidodendron* SP. (of the group of the *L. Volkmannianum* STBG.), and a new section of *Cardiopteris*, and for this and other reasons, Doctor Berg desired to prove that the deposit of carbon "at Retamito" belongs to the carboniferous formation i. e., it must be understood that he meant the great carboniferous formation in which the largest amount of coal occurs in Europe.

However, the evidence brought forward is not sufficient to prove the case, for the important reason that there is a long list of characteristic fossils, both *flora* and *fauna*, not found at the mines to which Doctors Berg and Brackenbusch refer at Retamito.

The formation of rocks in which the greatest body of coal is found in England and the United States, known as the great carboniferous formation, and located between the *Devonian* and *Permian*, has, in Great Britain, a thickness of 5000 feet, and in the United States of North America from 1000 to 14,000 feet, consisting generally of a serie of greyish compact sandstone beds with alternate beds of coal shale and indurate clay, and in this great period of carbonaceous deposits there exists no less than 2316 fossils of all classes, and among these there are at least 328 land plants.

Some of the leading and most characteristic fossil plants which distinguish this period of coal measures under consideration are as follows.

Pecopteris *lonchitica.*
Sphenopteris *crenata.*
Sphenopteris *linearis.*
Neuropteris *gigantea.*
Neuropteris *Loshii.*
Caulopteris *primæva.*
Lepidodendron *elegans.*
Lepidodendron *Stembergii.*
Sigillaria *reniformis.*
Sigillaria *reniformis.*
Lepidostrobus *ornatus.*
Stigmaria *ficoides.*
Asterophyllites *foliosa.*
Calamites *approximatus.*
Calamites *cannæformis.*
Calamites *mougeotii*, etc., etc.

Among the eminent list of European geologists and palæontologists, Prof. Prestwich is prominent, and when referring to the fossil remains found in the coal measures he says. "The largest assemblage in the kingdom of the remarkable Labyrinthodont amphibians is found in the coal-measures of country Kilkenny". I reland (Jarrow colliery), and that Prof. Huxley had discovered several specimens belonging to eight genera from a single coal mine. The smallest of these amphibians must have been from eight to nine inches, and the largest from five to six feet in length. Amongst them is the snake-like *Ophiderpeton*, the salamander-like *Keraterpeton* and the long-tailed *Urocordylus.*

Among the other species of invertebrate fauna there is a large number, all of which are well known to mining engineers, geologists, palæontologists and other scientists. The various writers who have, therefore, endeavoured to prove that the carbonaceous deposit at Retamito belongs to the great carboniferous period have not, in the opinion of the writer, proved their case.

However, there is one door of escape, and that is to prove that the greater portion of the carboniferous rocks which might have existed at Retamito have been denuded and carried away, and that which remains is only a small portion of that formation.

The same principle will hold good in regard to all the other places in this Republic where the great period of coal measures are supposed to exist.

From the data which precedes, it is evident that there exist in various parts of this country carboniferous deposits already discovered of a sufficiently good quality for a variety of uses, more especially in or near to the neighbourhood where they are found. Some of the coal deposits could be utilized for smelting purposes, and others for as; but the value of any of these deposits would depend upon the thickness of the beds of coal, and the area or extension over which they exist. In some cases these conditions also have been proved to be favourable, so much so that a formal exploitation would be justified.

Nevertheless, it has not been proved that any of the carbonaceous deposits belong to the *great carboniferous period*, the position of which in the series of strata has been formerly indicated. In point of fact, the writer firmly believes that that period has not as yet been discovered.

At the same time he is highly of opinion that, from scientific and practical examinations carried on by him in various parts of the country, it does exist in the Republic.

His Excellencey, the Minister of Agriculture, Commerce and Industries, Doctor Wenceslao Escalante, has initiated perforations in various parts of the country for the discovery of coal and mineral water springs.

However, in other countries, coal of great commercial value has been found in various parts of the newer formations above the *Permian* rocks, and the writer is convinced that the known carbonaceous deposits of the country may be referred to one or other of these.

The great point, therefore, is to procure capital for the object of exploiting the coal mines already discovered and to utilize it in the creation of an industry i. e., for the reduction of the various classes of metalliferous minerals so plentifully distributed throughout the vast extension of this country.

It is also true that coal may not exist always in likely places, or where it may be expected: on the country, however, it may exist in some of the most unlikely localities. The late Doctor Brackenbusch was, therefore, right when he referred to the Retamito fossils and deposit of coal as being a "mystification and that the remains of the vegetable fossils could have been artificially carried and deposited at the place referred to".

In proof of what has already been stated the writer offers the following curious circumstance.

When at the Chicago Exhibition in 1893, he inspected various geological sections of the coal bassin of San Jeronimo, in Brazil, and he was surprised to find that this coal formation was marked on the sections as resting upon a granitic formation, the argillaceous matter between the coal bed and the granite appearing to he very thin. The writer considered that some error existed, but on further examination he found that the section represented more than a single coal basin, but in continous order, exhibiting the same kind of formation in all of them.

Now, it is generally acknowledged that during the *great carboniferous period*, inmense forests of trees of gigantic size existed, as also innumerable plants, and the death of these and their transformation resulted in the formation of coal beds more or less thick, according to the extent of the forestal production.

The thickness of the successive beds of coal in England ranges from 2 to 30 feet in thickness, but the more general are from 3 to 6 feet.

In North America, the beds of coal range from 2 to 20 feet in thickness.

In Nueva Escocia there exist beds of coal from 12 to 38 fect in thickness, therefore the enormous mass of vegetation which produced material for these coal beds must have been phenomenal and must have continued growing in an augmented soil of great thickness.

Now, we do not apprehend that a granitic formation offerred suitable conditions for the support of such an enormous vegetable production and, consequently we cannot but infer that the thin carbonaceous matter under the bed of coal and the matter forming the coal bed itself at San Jeronimo was transported from another locality and deposited in the place where it is now found.

The writer has entered into this question at some length but it has a great scientific and practical interest, and may prove of service in searching for coal deposits in the country.

The depth of the carboniferous series of rocks from a known zone depends upon a variety of circumstances, chiefly, whether the entire formations are in the proper order of superposition, conformable the one to the other, and whetter either is absent from the series or has been denuded before the succeeding ones were deposited.

The writer intended to give a sketch of the studies of

various geologists such as D'Orbigny, Bravard, Burmeister, Aguirre, Berg, Brackenbusch, Döering, Moreno, Valentine, Ameghino, Bodenbender, Haüthal and others, as also of the geology of the country itself, but he found the time at his disposal was much too short to permit the subjects to he treated in a fair and comprehensive manner; but he proposes to enter upon these matters at a future period.

CHAPTER XXVI

General Observations and Data

In the name of the Ministry of Agriculture, Commerce and Industry of the National Government, the writer was commissioned to solicit the co-operation of the Provincial Governments and of the Governors of the various National Territories, in order that a proper and dignified official representation of the mining resources of the Republic should be made at the Saint Louis Exhibition in 1904, and for this object the National Offices of Mines and Geology passed circular notes soliciting information upon the state of the mining and metallurgical industries within the jurisdiction of each of these authorities.

However, it appears that as the writer had formerly suggested to the Ministry the necessity of procuring the mineral statistics of the country, various of the provinces had forwarded reports, and probably this circumstance led to the belief that there was no need of supplying additional data.

Be that as it may, the writer did not find in them such details as he needed for the present work.

The governors of the province of Catamarca and Salta, and of the National Territories of Misiones and Chubut complied

in the most affable manner with the indications of the writer and forwarded to him reports referring to the mines within their respective jurisdiction.

Province of La Rioja

Mr. William A. Treloar, the gentleman previously referred to, at the request of the writer initiated inquiries in all parts of this province, and presented a mass of valuable information.

The General Agent of "The Famatina Development Corporation Limited", Mr. Dangerfield, of Chilecito, also supplied information referring to the mines under exploitation by his Company which, together with the printed reports referring to the general state of the Company's affairs, enabled the writer to give some special information, which will be found in Chapter XXIII, upon metallurgy. After that chapter was printed, the writer received further information from Mr. Dangerfield as follows. "The work of the mines up to the present has been principally of a developing nature, and we have driven some 800 metres with the idea of putting as much ore in sight as possible, so that when the Rope way is completed we may be in a position to at once deliver ore to it". "No attempt has been made to exploit mineral with a view of realising commercially; but we have sent down some 1000 tons of picked ore from selected mines as a sample. For mule transport to Chilecito we paid 13 dollars per ton and 1·49 dollars paper per ton railway freight to Vichigasta smelting works (Patayaco).

The sample of 1000 tons referred to above has been smel ted in Patayaco, and cost 24 paper dollars per ton to smelt.

The crude mineral treated so far varies very much: the

average being (for this picked ore) 7 ½ °/₀ copper, 70 grammes of silver per mil kilos, and 18 grammes of gold per mil kilos.

The matte produced averages 53 °/₀ copper, 4·48 per mil silver and 0·127 per mil kilos of gold. Railway freight on matte to Rosario $ 34·15, and Ocean freight 18ˢ/—. We have no information as to sales as yet".

Aerial Ropeway:

The Railway to Chilecito placed this province in a different position to what it had some years since, but it did not facilitate the transport of the minerals from the mountain regions to the smelting works situated at lower levels, consequently, the National Government, with its usual liberality to the provinces, commissioned some of the Civil Engineering staff to make a study in the mountain regions with a view of installing there a better system of transport. This was effected and tenders offered for the construction of an aerial rope transport line.

To effect this object the contractors offered high wages for workmen, which has attracted many of the miners who were employed in the copper mines belonging to "The Famatina Development Corporation, Limited". Out of 300 miners formerly employed by it, the number has been so reduced that the Company has not a sufficient number of men to protect the mines according to the previsions of the law, and for this reason the general agent, Mr. Dangerfield, petitioned the National Government to grant a prorogation of the effects of the law. This matter was referred to the writer for technical opinion, and he recommended that the petition should be favourably considered.

Province of Catamarca

In order to obtain additional data referring to the present condition of mining in the Capillitas district, situated in this province, the writer communicated with the well known mining pioneer, Mr. Samuel Lafone Quevedo who kindly supplied valuable information and, also, used his influence with the new Capillitas Copper Company (London) soliciting data referring to its mining operations, and in consequence the General Managing Mining Engineer of the Company, Mr. A. Slack, was good enough to forward data and a printed report of the Company's workings as, also, drawings of the aërial ropeway now in construction from the mines to the new Establishment of Fundition. The writer has, consequently, been able to include in this work the latest information obtainable referring to the mining industry in this province.

The aërial cable line will have a length of 25 ½ kilometres, with a total fall of 1787 metres.

It is on the running rope system, and will be constructed in five sections, with four angle stations of about 163° each.

The capacity of this rope transport line is intended to carry 100 tons of mineral per day of 10 hours, but it is to be constructed for a maximum of 300 tons daily. It will be loaded from the mine floors, and will be discharged directly into the smelting bins. The contract has been placed in the hands of Messrs. Bullivant & C.°, Limited, London and the first shipment of materials was made in January of this year.

Supposing that the thorough development of the Capillitas mines and others, were to exceed 300 tons per day, arrangements could be made to work the aërial ropeway two or more shifts, one by day and the other by night, so that no diffi-

culty could occur, and this would give rise to the development of other mines.

Gold Mines Belonging to Doctor Adolfo Cano & Co.

The government has recently conceeded to this company auriferous quartz mines in the Cerro of Culampajal, in the Department of Belen. These mines were in concession in 1888 but were not exploited in a proper form for the want of capital.

The gold mines now conceded are called "*Descubridora*", "*Carmen*", "*Animas*", "*Sarab*" and "*Rosario*". The quartz is described as being whitish and dotted about with specks of gold.

The "Descubridora", is said to have been exploited by the Jesuits and others, the workings having attained a depth of 95 metres measured upon the inclination of the vein. When last visited by the owners water had infiltrated into the mine.

Three of these mines have been worked to depths of 10, 15 and 50 metres respectively.

Minerals extracted from the mines have yielded at the rate of from 45 to 120 grammes of gold per ton. Selected ores, assayed in Buenos Aires, yielded 230 grammes of gold per ton.

In the general collection of minerals which the writer exhibited at the Chicago Exhibition in 1893, were samples of gold ores from the mines of Doctor Cano, and that gentleman received an award for his exhibit.

The mines "Carmen", "Animas", "Anciana" and "Sahara" have yielded at the rate of from 45 to 130 grammes of gold per ton. The thickness of the veins of mineral ranges from 40 to 75 centimetres.

According to the report of Doctor Cano, there exists near to the "Carmen", a gold placer, similar to that of the Rinconada of the province of Jujuy, which could be exploited to great advantage, and water could be obtained from a stream situated at a distance of from one to two kilometres.

The same gentleman states that in the valley or gorges of Culampajal, there exists a sufficient quantity of wood which could be utilized for smelting ores.

Province of San Juan

Unfortunately no more generel information could be given of the mining industry of this province than that to be found in the Chapters N.° II and XI.

The mines of gold worked there by Mr. F. Sabattie have been referred to. From information which he has recently supplied, it appears that he possesses six mines in the district of Castaño Nuevo; but he has directed more attention to the development of a vein of mineral in the gold mine "*San Antonio*", which gives an average yield of 600 grammes of silver and 60 grammes of gold per ton. The battery he formerly employed only consisted of two stamp heads of 550 lbs. each, and in combination with the cyanide process he obtained monthly about 20 kilos of silver and 2 kilos of gold.

He has recently purchased a new stamp mill with five heads of 1000 lbs. each, which will be worked by a 50 horse power turbine. With this additional machinery he expects to treat 10 tons of mineral per day.

River Bed Explorations

Recently several parties interested in discovering alluvial gold washings have come to this country from Australia and New Zealand, and some of these gentlemen attracted a good deal of public attention, propositions being made by them to form syndicates and companies for the object of exploiting the auriferous sands found alongside the rivers, and in the river beds themselves. Naturally when notices, of this kind are given of such operations there is always, according to the daily papers, a new discovery.

It appears that a company was formed called the *Compañia Río San Juan de Oro*, to exploit alluvial Sands situated in the south of Bolivia, and as the river of the above name is situated to the north of the province of Salta it is not improbable that the auriferous sand deposits may extend into that province; as formerly indicated.

Applications for gold concessions were also made to the Ministry of Agriculture to dredge the river Negro and others in the southern National territory of the Republic, and when these came to the Offices of Mines to be reported upon, it was found that the applications were not clearly defined.

The parties were, therefore, requested to explain their intentions and ideas in a more concise form; but up to date, this order has not been complied with.

Other similar propositions to dredge in different river beds have been made, but the writer has no reliable data as to the proceedings.

Railway and Other Means of Transport

We have already given a notice of the aërial rope line of transport, which the Capillitas Company is about to con-

struct, in a former chapter, but it will not be so difficult and costly as the one now in course of construction by the National Government from Chilecito to the station near to the Mejicana mines in the province of La Rioja.

A survey of the route from Chilecito to the Mejicana district was as previously noticed made by a commission of Civil Engineers belonging to the Ministry of Public Works, and Mr. Juan J. Shereden Russell, before mentioned was an active member of that commission.

He was afterwards commissioned to examine the route and works required to be made. It is constructed at the expense of the National Government and is estimated to cost 850,000 dollars gold, or £ 168,650.

Section of Aërial Transport Line

The total distance of this rope transport line from the first station at Chilecito to the last near the Mejicana district is divided into 8 sections, the distance of each, and their heights above sea level, are exhibited in the following table.

	Height in Metres	Distance in Kilometres	Horizontal Angles Between Each pair of Sectional Lines	Difference of Level Between the Stations
Upulungos . . .	4603·58	34·329	—	—
Bayos	4371·44	30·878	149	231·94
Calderita Nueva. .	3910·91	27·805	160	460·53
Celito	3244·00	25·538	163	666·91
Cuevas de Romero.	2689·42	23·592	169	554·58
Rodeo de las Vacas.	2539·66	20·497	175	149·76
Parron	1974·48	17·448	167	565·18
Kilometro 9 . . .	1539·43	8·957	178	435·05
Chilecito	1075·60	0·000	—	463·83

The total distance amounts to 34·329 kilometres and height to 4603·58 metres, the difference of level between the two extreme ends of the line amounting to 3527·98 metres. All these heights are referred to sea level. It is proposed to place a motive power between each alternate pair of stations.

This aerial line will be administered by the National Government and if the charge of transport should be fixed at the rate of $ 10 per ton, it would be greatly in favour of the miners; but the profit to be derived to the government is a question which depends upon so many circumstances that an estimate cannot now be given.

This transport line and that referred to in the province of Catamarca are the only ones of the class in the Republic and whether the government will decide to apply this system of transport in the other mining regions, is a matter for future consideration and discussion.

Mule Transport

This is the general system employed throughout the country for the transport of minerals from the various mining regions, and the charge per ton and per kilometre varies according to the difficulties and distance to be overcome, as, also, upon the resources and facilities which exist for labour and maintenance.

Mules vary in quality as well as in price in different parts of the Republic; but good ones may be purchased at the rate of 60 paper dollars each, and Mr. A. Flajollet, to whom the writer is obliged for information, made a six days journey from Salta to a place called Siberia in the National Territory of the Andes, and he says that he paid 1 $^1/_2$ paper dollars per day for each mule including maintenance.

Prof. Juan B. Ambrosetti, Inspector of Mines, in the National Offices ot Mines and Geology was commissioned to form part of a govenment exploring expedition to the borate of lime district of Caurchari, Territory of the Andes, and on his return presented to the writer a very extensive and interesting official report. He also states that a good mule can he hired and maintained for 1 $^1/_2$ paper dollars per day.

In such difficult places of access as that referred to, it is necessary to employ extra mules for the object of transporting all that is required for the maintenance of the personal and animals depending, naturally, upon the distance to be traversed, and time occupied in exploring.

National Territory of Chubut

In Chapter XX, page 340, mention has been made of the Salt company in the Peninsula Valdez, but when it was written no analysis of the salt was at hand, however, further inquiry induced the company to furnish the following comparative analysis.

NATURE OF ELEMENTS	Cadiz salt (Spain)	Salt of Ibiza (Spain)	Salt of Torres Vieja (Spain)	Salt from Peninsula Valdez (Argent. Rep.)
Matter, insoluble in water	0·3880	0·3400	0·0320	0·0200
Water	7·1140	5·9000	2·5000	1·8000
Oxide of Calcium	0·0160	0·0224	0·0110	0·0566
Oxide of Magnesia	0·0972	0·1080	traces	traces
Sulphuric Acid	0·3819	0·6517	0·5280	0·0411
Chloride of Sodium	92·0982	92·9757	96·8942	98·0616

These analysis were made by Dr. Lavalle in 1902.

It will be observed that the Chubut salt is superior to any of the well known salts of Spain.

National Territory of Santa Cruz

The salt mines referred to in Chapter XXI, page 343, belonging to Messrs. L. Parmeggiani & Company, are situated inland at a distance of about 7 leagues from the port of Cabo Blanco, on the Patagonian coast, 1000 miles from Buenos Aires.

During the winter season the so-called mines form a saline lake extending over an area of 1000 square hectares, but when the hot weather commences, the water of the lake evaporates leaving the place it occupied quite dry in about the month of December, and remains in that condition until May and June when the rainy season again fills the lake.

The salt is deposited during the dry season over the entire area, and is broken and placed in heaps upon the surface.

It is submitted to atmosperic action and becomes more or less purified according to the duration of exposure.

The salt has a brillant whiteness and may be immediately despatched to the market.

Each workman can extract from the deposited salt bed about 7 tons per day, so that only a comparatively small number of employees are necessary and, consequently, the cost of exploitation is small.

The Company reports that during a period of two months 30,000 tons of Salt has been extracted.

When the lake is filled, the water becomes strongly impregnated with salt, so that it is an inexhaustible salt mine

The Company has a Decauville railway from the lake to the coast, so that any amount of salt can be transported.

The following analysis of the salt, made in 1902, sulffices to establish its quality:

Water.	1·9802 %
Organic matter.	traces "
Sand	0·2052 "
Chloride of sodium	95·6955 "
Sulphate of calcium	1·3212 "
" " magnesia	0·1655 "
Chloride " "	0·3250 "
Other impurities such as silica, iron, alumina and loss. . . .	0·3294 "

The above analysis was made in the National Offices of Chemistry, Buenos Aires, and it is asserted that it was made from a sample of crude salt before it was purified.

The port of Cabo Blanco is beautifully situated and sheltered from all winds, having the form of a horse-shoe with a width of 700 metres and 1000 metres long, or inland from the sea. It has a depth of water from 20 to 50 metres so that it offers every facility and protection.

There are two services of steamers entering this port from Hamburg, as also Transports of the National Navy. The salt is also transported in sailing ships.

There is a national telegraph office in this port so that continual communication is made with the capital.

Province of Mendoza

The mine "*Esperanza*" is situated in the mining district of *La Cortaderita*, and at a distance of about 14 kilometres in a western direction. It appears to belong to Dr. Salas and is located at an altitude of 2500 metres above sea level. The vein of mineral is thin not having more than 0·25 centimetres of thickness, and is described as a mineral containing sulphide of lead with chloride of silver in a ferruginous base, but it also contains a much larger quantity of oxide of manganese than it does of iron.

The occurrence of silver in manganése ore is not common in this country, neither is it abundant in others where it has occurred in the United States and Mexico.

This ore has, however, another curious and rare feature, and that is, that it contains visible gold in specks and filaments, but the gold does not appear to be disseminated throughout the samples in equal quantities.

However, a sample in the possession of the writer, exhibits a large quantity of gold at sight and in the form of bunches. The colour of the ore is black, not very compact and more inclined to be spungy. No doubt the greater part of the gold is disseminated thoughout the mass in a fine invisible powdered condition.

Various samples of this mineral were sent to the National Mint to be assayed by Dr. Kyle, a complete assay of which he published in the "Anales de la Sociedad Científica Argentina", tomo XLVII, p.p. 143 and following, a copy of which is reproduced as follows:

Water in combination. .	7·340 °/₀	
Bioxide of manganese. .	72 910	manganese 52·02
Protoxide of manganese .	7·740	
Oxide of zinc	0·800	
Ferric oxide	3·700	
Oxide of calcium . . .	2·000	
Chloride of silver . . .	0·822	silver 0·624 chlorine 0·198
Gold	0·004	
Antimony.	0·419	
Lead	0·546	
Sulphur	0·247	
Silica	3·400	
	99·928	

Dr. Kyle says that from the analysis it is seen that the mineral obtained from the mine "Esperanza" is very complex, the vein being formed principally of anhydrous and hydrous oxide of manganese, but a little ferruginous, carrying in a mixed form small quantities of sulphur, lead, antimony, zinc, silver and gold. He adds that he has determined that some of the samples of ore from the mineral vein have yielded silver as high as from 1·3 to 1·5 per cent.

This is a very curious as well as interesting class of mineral and may be considered to be of rare occurrence.

Province of Jujuy

The Rinconada Exploring Syndicate Limited, with offices at 96 Bishopsgate street, London, has been previously referred to in Chapter IX, page 223 The engineer of the Syndicate, Mr. Florence O'Driscoll has minutely examined this part of the country; but he says "This Report will be peculiar in its nature, because it cannot be definite; it will be merely the sketchy

impression of a whole country side, which can best be proved by actual work; for I think the results, were they set out, of the little sampling that was possible, might lead to erroneous conclusions. I am of opinion that work properly directed will not only do the sampling and prospecting, but also bring in returns, in some cases perhaps not sufficient to pay expenses, in others a handsome profit.

I cannot express to you in a definite figure the size of the actual prospecting concessions, but they exceed 120,000 acres, dotted here and there over a tract of country exceeding one million acres in extent, all of which you could also prospect were it possible or expedient. The greater part lies in a wild, unprospected and unsurveyed country, some 12,000 to 15,000 feet above sea level. My journey through that region was a more or less continuous mule ride, and occupied 43 days, from the 27th June to the 9th August last". (1903).

"In the main this country is metalliferous. I examined in detail almost every known vein and reef that had been opened out and prospected for the past twenty or twenty-five years. Indeed my examinations went much further than this, for some of the veins I saw were reputed to have been opened out by Spaniards 200 to 300 years ago, and others were stated by the Indians to be workings left by the Incas".

Further on in his Report the Engineer states "Here you must be alluvial miners, and in my opinion there is a large field open to you where with very little capital, an early return may be obtained and where, if the result of a small syndicate work proves the ground to be valuable, there are alluvial deposits large enough to establish works on a large scale".

Discussing the results of former explorations effected by "Engineers and 200 to 300 workmen", Mr. O'Driscoll says. "Personally I am of opinion that if this alluvial wash holds one tenth of what it is reputed to contain, there will be fortune

enough for half-a-dozen prospecting companies in the Ajedrez concessions alone".

Again, referring to some workings on a small scale, it is further stated "that for every dollar expended, about two dollars worth was calculated", and, also, that "ten men collected gold to the value of £ 140 per month".

This report is very interesting, and is an exceptionally practical one. A large region examined is described as consisting of slate, but it is stated that no fossils could be found.

It is highly probable that this slate formation belongs to the lower *Silurian period.*

Another Company, or Syndicate, in which Messrs. Tetley and Moncrieff are concerned, seem to have in hand the exploration of auriferous deposits, also, upon the Orosmayo, Santa Catalina and other districts, and the results appear to have been so satisfactory that is stated that they have been induced to import a dredging machine.

Analysis of Mineral Waters of The Republic

As a certain amount of interest is now being taken in the question of mineral waters which may be obtained from subterraneous springs, the writer considers that it would be of general interest to give a short notice upon what has been already achieved during many years in the past, and the principal work upon this question is that published in the "*Anales de la Sociedad Científica Argentina*" Vol. XLIII,b y Dr. J. J. J. Kyle.

The memoria consists of 41 pages, 28 of which consist of Tables of an exceedingly large number of complete analysis of the mineral waters of the Republic. The immense amount of labour devoted to this study over many years, and value o

the determinations cannot he over estimated, and their great importance ought to be more widely known. In fact, the data afforded by the publication referred to proves to a demonstration that the mineral waters already discovered and their qualities thus made known, are sufficient for all practical purposes in the Republic and leaves nothing to be desired. The only thing needed is the practical utilization of the mineral waters with a view of benefitting the exploiters and the Nation at large.

There is a wide field open to persons who may be disposed to invert capital in undertakings of this nature which must of necessity yield sufficiently large returns.

Coal Deposits in The Argentine Republic

When treating of the many analysis which have been made over a long series of years of the Argentine coal treated in Chapter XXIV of this work, it was omitted to be noted tha the heating power of the coal samples in each case was determined by the method of Berthier, which mode has been employed for many years throughout the world, and even to day some of the most noted and experienced metallurgical Chemists prefer it because it represents the results sufficiently close which may be obtained in practical working upon a large scale.

The modes of determining the heating power of coal by the instrument called *Calorimetre*, has been long known in England, especially the instrument of that class invented many years since by Thompson. This instrument, and others are employed largely in Great Britain. The French type instrument or *Calorimetre* is used in the same form.

This instrument may be found illustrated in various English and French works upon Chemistry.

What may be deduced from all that has been advanced upon the coal question of this Republic, is the practical utilization of the carbonaceous deposits which have already been discovered for such a long period, and for this it is necessary to induce capitalists to develope this important industry.

Mineral Statistics

Due to economic reasons the National Congress has for a considerable time past ceased to vote special funds for a detailed inspection of the mines of the Republic, and consequently, the National Offices of mines and geology, possessed no returns of the annual production of the mines.

Besides, the provincial governments have no special organised legal mode of compelling the mining companies and miners to supply periodically, mining statistics, and, for these reasons, neither the National or Provincial governments possess data by which to determine the exact value of the annual produce of the mines of the country. However, were it known to be comparatively small in amount, it could not be taken as a measure of the great importance the mining industry could have in the future.

In order to raise the mining and metallurgical industries of this country to a high and flourishing condition, such as it exists in the older countries of the mining world, it is absolutely necessary to stimulate it in all possible legitimate forms and by an honourable propaganda, induce the introduction of foreign capital.

It is certain that recently a new impulse has been given to mining, by the introduction of various strong English Companies, and no doubt other companies will follow the initiative.

There exists in this country a wide field for the profitable employment of capital.

Personal

The writer desires to express his high sense of the patronage and uniform kindness which he has received from the various Presidents of the Republic, from the time of His Excellency Teniente General Julio A. Roca (1886) up to the present, their various successive Ministers, Secretaries of State, Senators and Deputies of the National Congress, Professors in the Universities, political and other social friends during a period of 21 years residence in this country, 18 of which the writer has had the honour to occupy the position of chief advising and acting mining Engineer to the National Government.

Of his more immediate official friends the writer is desirous to render his thanks to Doctor Carlos Ibarguren, Engineer Segui, Doctor Federico Cibils, Doctor Torino, Doctor J. J. J. Kyle, Doctor Galarce, Engineer Eusebio E. Garcia, other chiefs of public offices, Editors and other members of the press of Buenos Aires from all of whom he has received the greatest kindness, attention and support.

The writer also presents his acknowledgement and thanks to all those gentlemen whose names appear in the body of this work who hare given information and assistance, as also to a large list of other friends too numerous to be enumerated; but, at the same time, he cannot refrain from noticing and thanking the first mining Engineer of the National Offices of Mines and Geology, Mr. Carlos A. Lines Hoskold, for his colaboration in this, as in various other scientific works published by the author.

APPENDIX

CATALOGUE OF THE OFFICIAL COLLECTION OF MINERALS

FROM THE MINES

OF THE

ARGENTINE REPUBLIC

AND SENT TO THE

INTERNACIONAL EXHIBITION OF St. LOUIS

United States of North America

1904

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
1	1	Enargite, famatinite, green carbonate of copper	Verdiona	Mejicana	Rioja
	2	Enargite, famatinite, green carbonate, chalcopyrite.	—	—	—
	3	Enargite, famatinite, green carbonate	—	—	—
	4	Enargite, malachite, chalcopyrite.	Upulungos	—	—
	5	Enargite, chalcopyrite, green carbonate	—	—	—
	6	Enargite, famatinite, chalcopyrite, green carbonate	—	—	—
	7	Enargite, chalcopyrite, famatinite.	—	—	—
	8	» malachite, »	—	—	—
	9	» chalcopyrite, »	—	—	—
	10	» » malachite, famatinite.	—	—	—
	11	Chalcopyrite, enargite, famatinite.	—	—	—
	12	Enargite, famatinite, chalcopyrite, green carbonate	—	—	—
	13	Enargite, chalcopyrite	—	—	—
	14	» » green carbonate of copper	Verdiona	—	—
	15	Enargite crystalized, famatinite, chalcopyrite, green carbonate and sulphate of copper	Upulungos	Mejicana	—
	16	Enargite, famatinite, green carbonate, chalcopyrite.	—	—	—
	17	Enargite crystalized, chalcopyrite, green carbonate	Sto. Toribio	—	—
	18	Enargite, chalcopyrite.	—	—	—
	19	» famatinite, green carbonate, chalcopyrite.	—	—	—
	20	Enargite crystalized, chalcopyrite, green carbonate	—	—	—
	21	Enargite, chalcopyrite, famatinite.	Upulungos	—	—
	22	» » » with green carbonate and sulphate of copper.	—	—	—
	23	Enargite, chalcopyrite, malachite.	—	—	—
	24	» » green carbonate	—	—	—
	25	» » » »	—	—	—
	26	» » » »	—	—	—
	27	» » » »	—	—	—
	28	» » » »	—	—	—
	29	» » » »	—	—	—
	30	» » » »	—	—	—
	31	Enargite and famatinite	Upulungos	Mejicana	—
2	32	23 large samples of enargite, chalcopyrite, etc., from the mines of señor Koch	—	—	—
3	32 a	Enargite chalcopyrite.	Upulungos	—	—
	33	Pyrites of iron and copper	—	—	—
	34	Enargite crystalized, famatinite, chalcopyrite	—	—	—
	35	Enargite, chalcopyrite.	—	—	
	36	» famatinite	—	—	—
	37	» » green carbonate.	—	—	—
	38	» crystalized	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	39	Enargite, chalcopyrite.	Upulungos	Mejicana	Rioja
	40	» » famatinite . . .	—	—	—
	41	» famatinite	—	—	—
	42	» »	—	—	—
	43	» » chalcopyrite . . .	—	—	—
	44	» » » . . .	—	—	—
	45	» » » . . .	—	—	—
	46	» chalcopyrite.	—	—	—
	47	» crystalized	—	—	—
	48	» chalcopyrite, malachite . . .	—	—	—
	49	» famatinite. chalcopyrite. . . .	—	—	—
	50	» » » . . .	—	—	—
	51	» » » . . .	—	—	—
	52	» » » . . .	—	—	—
	53	» » » . . .	—	—	—
	54	» » » . . .	—	—	—
4	55	» » » . . .	—	—	—
	56	» » » . . .	—	—	—
	57	» » » . . .	—	—	—
	58	» » » . . .	—	—	—
	59	» » » . . .	—	—	—
	60	» with green carbonate . . .	Mellizas	—	—
	61	» » » » chalcopyrite, quartz.	—	—	—
	62	Enargite, famatinite, chalcopyrite. . .	—	—	—
	63	» » » . . .	—	—	—
	64	» » » with sulphate of copper	—	—	—
	65	Enargite, famatinite, calcopyrite . . .	—	—	—
	66	» » » . . .	—	—	—
	67	» » » . . .	—	—	—
	68	» carbonate, pyrites of copper . .	San Pedro	—	—
	69	» crystalized, famatinite, chalcopyrite	—	—	—
	70	Enargite, famatinite, chalcopyrite. . .	—	—	—
	71	» crystalized, famatinite, chalcopyrite.	—	—	—
	72	» » » »	—	—	—
	73	» » » »	—	—	—
	74	» » » »	—	—	—
	75	» » » » with sulphate	—	—	—
	76	Enargite crystalized, famatinite, chalcopyrite	—	—	—
	77	Enargite crystalized, famatinite, chalcopyrite	—	—	—
	78	Enargite, chalcopyrite.	Andueza	—	—
	79	» » green carbonate. .	—	—	—
	80	» crystalized, famatinite, green carbonate	—	—	—
	81	Enargite crystalized, famatinite, green carbonate	—	—	—
	82	Enargite crystalized, famatinite, chalcopyrite	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	83	Enargite crystalized	San Pedro	Mejicana	Rioja
	84	» » chalcopyrite . . .	—	—	—
	85	» famatinite, copper pyrites, gren carbonate	—	—	—
	86	Enargite crystalized, famatinite, chalcopyrite	Verdiona	—	—
	87	» » » »	—	—	—
	88	» » » »	—	—	—
	89	» » » »	—	—	—
	90	» » » »	—	—	—
	91	» » » »	—	—	—
	92	» » » »	—	—	—
	93	» » » »	—	—	—
	94	» » » »	—	—	—
	95	» » » »	—	—	—
		OBSERVATION: All the samples of mineral from N.° 1 to N.° 95, are high in percentage of copper, and also contain gold and silver in more or less quantity.			
5		Carbonates, mixed with cuprite, ochre, silver.	Various	—	—
	97	» » » » »	—	—	—
	98	» » » » »	—	—	—
	99	» » » » »	—	—	—
	100	» » » » »		—	—
	101	» » » » »	—	—	—
	102	» » » » »	—	—	—
	103	» » » » »	—	—	—
	104	» » » » »	—	—	—
	105	» » » » »	—	—	—
	106	» » » » »	—	—	—
	107	» » » » »	—	—	—
	108	» » » » »	—	—	—
	109	» » » » »	—	—	—
	110	» » » » »	—	—	—
	111	» » » » »	—	—	—
	112	» » » » »	—	—	—
	113	Pyrite and oligistic iron ore containing gold	San Diego	El oro	—
	114	Pyrite and oligistic iron ore containing carbonate of copper carrying gold . .	—	—	—
	115	Oligistic iron ore with pyrites containing gold	—	—	—
	116	» » » » »	—	—	—
	117	» » » » »	—	—	—
	118	Cerussa (carbonate of lead).	—	Sañagasta	—
	119	» » »	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	120	Melaconite (black oxide of copper), enargite, green carbonate	Argentina	Mejicana	Rioja
	121	Enargite, chalcopyrite, black oxide of copper	—	—	—
6	122	Native and sulphide of silver, blende	San Pedro	Cerro Negro	—
	123	Sulphide of silver, blende, quartz	—	—	—
	124	» » » »	—	—	—
	125	» » » »	—	—	—
	126	» » » »	—	—	—
	127	» » quartz, iron	—	—	—
	128	» » »	Sto. Dom'go	—	—
	129	» » »	—	—	—
	130	Native silver, sulphide, blende, quartz	Puerto	—	—
	131	Sulphide of silver	San Andrés	—	—
	132	Ruby silver, sulphide, blende, quartz	Atahualpa	Tigre	—
	133	Sulphide and native silver, blende, quartz	—	—	—
	134	Sulphide of silver, quartz	San Pedro	Cerro Negro	—
	135	» » » blende, quartz	Sto. Dom'go	—	—
	136	» » » » »	—	—	—
	137	» » » » »	—	—	—
	138	» » » charcopyrite	—	—	—
	139	» » » blende, quartz	—	—	—
	140	» » » quartz	—	—	—
	141	» and native silver	Infierno	—	—
	142	» » » » blende	Esperanza	Caldera	—
	143	Sulphide of silver, blende	—	—	—
	144	» » » »	San Pedro	Cerro Negro	—
	145	» » » »	Sto. Dom'go	—	—
	146	» » » » quartz	—	—	—
	147	» » silver, blende	—	—	—
	148	» with dark ruby silver (kerargyrite)	—	—	—
	149	Sulphide of silver, blende	—	—	—
	150	» » » quartz	San Andrés	—	—
	151	» » »	San Miguel	Tigre	—
	152	» » » quartz	San Pedro	Cerro Negro	—
	153	» » » »	Sta. Teresa	—	—
	154	» » » light ruby silver (proustite) blende	San Miguel	Tigre	—
	155	Sulphide of silver, quartz	—	—	—
	156	» » »	—	—	—
	157	» » »	—	—	—
	158	» » » blende	Sto. Dom'go	Cerro Negro	—
	159	Limonite containing native and sulphide of silver.	San Andres	—	—
	160	Limonite containing native and sulphide of silver.	—	—	—
	161	Sulphide of silver, limonite, blende	—	—	—
	162	» and bromide of silver, ochre.	—	—	—
	163	Native and sulphide of silver, ochre.	—	—	—
	164	» » »	—	—	—
	165	» » »	—	—	—
	166	» » »	—	—	—
	167	Native silver	Sto. Dom'go	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	168	Argentite, native silver, ochre	Peregrina	Cerro Negro	Rioja
	169	» » » »	—	—	—
	170	Native and sulphide of silver.	St. Domingo	—	—
	171	» » » » »	—	—	—
	172	» » » » » with blende and quartz.	—	—	—
	173	Native and sulphide of silver, blende . .	—	—	—
	174	» silver	—	—	—
	175	» and sulphide of silver	—	—	—
	176	Sulphide of silver in quartz.	—	—	—
	177	Native and sulphide of silver, blende, quartz	—	—	—
	178	Sulphide of silver, blende, quartz . . .	Puerto	—	—
	179	» » » » »	—	—	—
	180	» and bromide of silver, blende. .	—	—	—
	181	Argentite, ruby silver (proustite) blende.	Peregrina	—	—
	182	Sulphide of silver	—	—	—
	183	Argentite	—	—	—
	184	Sulphide of silver.	—	—	—
	185	» » » blende, limonite . .	—	—	—
	186	Native and sulphide of silver	—	—	—
	187	Sulphide of silver	—	—	—
	188	Native and sulphide of silver, blende. .	—	—	—
	189	Proustite, sulphide of siiver	—	—	—
	190	Ruby silver crystalized	—	—	—
	191	Crystalized ruby silver	—	—	—
	192	» » » and sulphide . . .	—	—	—
	193	Pyrargyrite, and sulphide of silver . . .	—	—	—
	194	Proustite, or light red ruby silver and sulphide.	—	—	—
	195	Proustite, or light red ruby silver and sulphide.	—	—	—
	196	Light red ruby silver, sulphide, quartz. .	—	—	—
	197	» » » » » » . .	—	—	—
	198	» » » » » » . .	—	—	—
	199	Dark » » » » » . .	—	—	—
7	200	Regulus containing copper, silver, gold.	—	—	—
	201	» » » » »	—	—	—
	202	» » » » »	—	—	—
	203	» » » » »	—	—	—
	204	» » » » »	—	—	—
	205	» » » » »	—	—	—
	206	» » » » »	—	—	—
	207	» » » » »	—	—	—
	208	» » » » »	—	—	—
	209	» » » » »	—	—	—
	210	» » » » »	—	—	—
	211	» » » » »	—	—	—
	212	» » » » »	—	—	—
	213	» » » » »	—	—	—
8	214	Matte containing copper, gold and silver from the Establishment at Chilecito . .	—	Chilecito	—
	215	» » »	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	216	Matte containing copper, gold silver from the Estabilishment at Chilecito	—	Chilecito	Rioja
	217	» » »	—	—	—
	218	» » »	—	—	—
	219	» » »	—	—	—
	220	» » »	—	—	—
	221	Ferruginous conglomerate containing gold	Piedras Grandes	Mejicana	—
	222	» » » » »	—	—	—
	223	» » » » »	—	—	—
	224	» » » » »	—	—	—
	225	» » » » »	—	—	—
	226	» » » » »	—	—	—
	227	» » » » »		—	—
	228	» » » » »	—	—	—
	229	» » » » »	—	—	—
	230	» » » » »	—	—	—
9	231	Cuprite, malachite, limonite melaconite.	Grande	Capillitas	Catamarca
	282	» » » »	—	—	—
	233	» » » »	—	—	—
	234	» » » »	—	—	—
	235	» » » »	—	—	—
		blue aud green carbonate	—	—	—
	236	Melaconite, pyrites of iron.	—	—	—
	237	Cuprite, green carbonate, ochre. . . .	—	—	—
	238	» » » limonite. . .	—	—	—
	239	» » » » . . .	—	—	—
	240	» » » » . . .	—	—	—
	241	» » » » . . .	—	—	—
	242	» » » » . . .	—	—	—
	243	» » » » . . .	—	—	—
	244	» » » » . . .	—	—	—
	245	» » » » . . .	—	—	—
	246	Chalcopyrite	—	—	—
10	247	» » grey copper	Santa Clara	—	—
	248	Green and blue carbonates, grey copper cerussa, quartz	—	—	—
	249	Covelline, melaconite, grey copper . . .	—	—	—
	250	Chalcopyrite, bornite, carbonates of copper	restauradora	Hoyada	—
	251	Covellite, bornite, melaconite	—	Capillitas	—
	252	Cuprite, melaconite, limonite	Ortiz	—	—
	253	Chrysocolla, cuprite, ochre.	Santa Clara	—	—
	254	Covelline, chalcopyrite, grey copper . .	—	—	—
	255	» melaconite, bornite.	restauradora	—	—
	256	Azurite, cuprite, ochre	—	—	—
	257	Malachite, cuprite, azurite	Santa Clara	—	—
	258	Cuprite, malachite, grey copper	—	—	—
	259	» » chrysocolla	—	—	—
	260	Malachite, melaconite.	—	—	—
	261	Cuprite, malachite.	—	—	—
	262	Blu e and green carbonates, cuprite . . .	—	—	—
	263	Chalcanthite, malachite, ochre.	—	—	—
	264	Cuprite, green carbonate, grey copper. .	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	265	Cuprite, malachite, chalcopyrite. . . .	Santa Clara	Capillitas	Catamarca
	266	» »	—	—	—
	267	» blue and green carbonates of copper	—	—	—
	268	Melaconite (black oxide of copper) . . .	Grande	—	—
	269	»	—	—	—
	270	»	—	—	—
	271	»	—	—	—
	272	Covelline, melaconite, bornite chalcopyrite	Restaurad'ra	—	—
	273	» » » »	—	—	—
	274	» » » »	—	—	—
	275	» » » »	—	—	—
	276	» » » »	—	—	—
	277	Melaconite » » »	Grande	—	—
	278	Covelline » » »	Restanrad'ra	—	—
	279	Chalcopyrite, bornite.	—	—	—
	280	Melaconite.	Grande	—	—
	281	Galena.	Argenttna	—	—
	282	Chalcopyrite, covellite, bornite . . .	Restanrad'ra	—	—
	283	Covelline, melaconite.	Santa Clara	—	—
	284	Titanic iron ore.	Romay	Romay	—
	285	» » »	—	—	—
	286	Limonite	—	—	—
	287	Hematite	—	—	—
	288	Galena.	Argentina	Capillitas	—
	289	» chalcopyrite	—	—	—
	290	Malachite, chalcosine, hematite	Grande	—	—
	291	Galena.	Argentina	—	—
	292	Melaconite	Restaurad'ra	—	—
	293	Galena, cerussa, limonite	Ortiz	—	—
	294	» » »	—	—	—
	295	» » »	—	—	—
	296	» » »	—	—	—
	297	Chalcopyrite with spots of melaconite . .	Restaurad'ra	—	—
	198	» » » » » . .	—	—	—
	299	» » » » » . .	—	—	—
11	300	Cuprite, malachite, covellite	Grande	—	Rioja
	301	» » . limonite, ochre . . .	—	—	—
	302	» » » » . . .	—	—	—
	303	» » » » . . .	—	—	—
	304	» » » » . . .	—	—	—
	305	» » » » . . .	—	—	—
	306	» » » » . . .	—	—	—
	307	Chalcopyrite, bornite, covellite	—	—	—
		METALLURGY			
		Establishment of Fundition, Pilciau			
12	307a	Bar of copper bottoms containing gold and silver	—	—	—
	308	Bar of copper bottoms, 2.d class containing gold and silver	—	—	—

Number of box	Number of sample	CLASSIFICATION	Mine	District	Province
	309	Bar of copper bottoms, 2d. class, containing gold and silver.	Grande	Capillitas	Rioja
	310	» » »	—	—	—
	311	Matte. 65 % of copper, with gold and sirver.	—	—	—
	312	First bar of iron cast in the Republic from the iron ore mines «Romay». . . .	—	—	—
13	313	Argentiferous galena with antimony. . .	Garibaldi	—	Córdoba
	314	» » » » . . .	—	—	—
	315	» » » » . . .	—	—	—
	316	» » » » . . .	—	—	—
	317	» » » » . . .	—	—	—
	318	» » » » . . .	—	—	—
	319	» » » » . . .	—	—	—
	320	» » » » . . .	—	—	—
	321	» » » » . . .	—	—	—
	322	Auriferous quartz, carbonate of lead . .	San Ignacio	—	—
	323	» » chalcopyrite, iron . .	—	—	—
	324	Ferruginosis quartz with native gold . .	Natividad	—	—
	325	» » » » . .	Cortadera	—	—
	326	» » » » . .	—	—	—
	327	» » » » . .	—	—	—
	328	Auriferous quartz	Antigullo	—	—
	329	» »	Agua Cala	—	—
	330	Galena, cerussite, quartz.	Chani	—	—
	331	» blende	Candelaria	—	—
	332	Argentiferous lead with antimony . . .	—	—	—
	333	Cerussite, antimony, quartz.	—	—	
	334	Galena, antimony, pyromorphite, baryta .	Chani	Chani	—
	335	Galena, baryta	Herminia	—	—
	336	Ferruginous auriferous quartz.	—	—	—
	337	Galena, cerussite, antimony.	Elisa	—	—
	338	»	—	—	—
	339	Ferruginous auriferous quartz.	Ventanayo	—	—
	340	Galena, antimony, quartz	—	—	—
	341	» hematite, quartz	—	—	—
	342	» » »	—	—	—
	343	» malachite, limonite	—	—	—
	344	Chalcopyrite, ochre	Tauro	Telhbrand	—
	345	Blue and green carbonates of copper . .	Tío	Calamuchita	—
	346	Chalcopyrite, magnetite, etc.	—	—	—
	347	» » »	—	—	—
	348	Ferruginous auriferous quartz.	Republicana	Río Hondo	—
	349	» » »	—	—	—
	350	Magnetic iron ore.	Potrero de Loza	Anejo del Norte	—
	351	Wolfram	—	Calamnchita	—
	352	Auriferous quartz, chalcopyrite	R. Barrancas	—	—
	353	Manganiferous iron ore.	Rosario	Cruz del Eje	—
	354	Magnetite	—	—	—
	355	Galena, blende, pyrite, quartz	Eufemia	Minas	—
	356	Argentiferous lead ore	S. Jerónimo	—	—
	357	» » »	San Agustín	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	358	Chalcopyrite	Tauro	Tauro	Córdoba
	359	Galena, cerusite, oche	—	—	—
	360	»	—	—	—
	361	Crysocolla, cerussité, quartz	—	—	—
	362	Hæmatite	Dolores	—	—
	363	Galena, cerussa, quartz	—	—	—
	364	Galena	—	—	—
	365	Galena, cerussite, quartz	—	—	—
	366	» » »	Elisa	—	—
	367	« » »	Agua Cala	—	—
	368	Auriferous quartz	San Ignacio	—	—
	369	Limonite, chalcopyrite	—	—	—
	370	Ferruginous auriferous quartz	—	—	—
14	371	Galena, cerussite, quartz	Chacabuco	Q. del Toro	Salta
	372	» » chalcopyrite	—	—	—
	373	» » ochre	—	—	—
	374	Limonitte, carbonate of iron	—	—	—
	375	Malachite, grey copper, chalcosine	—	—	—
	376	Grey copper	—	—	—
	377	Galena and copper	—	—	—
	378	Grey copper	—	—	—
	879	Cuprite, blue and green carbonates, chalcosine	—	—	—
	380	Cuprite, carbonates, chalcopyrite chrysocolla	—	—	—
	381	Hæmatite, ochre	—	—	—
	382	Galena, carbonate of copper cerussite	—	—	—
	383	Galena, carbonate, of lead	—	—	—
	384	Grey copper, chalcopyrite, chalcossine with gold and silver	Concordia	S. Antonio de los Cobres	—
	385	Galena chrysocolla, limonite and cerussite	—		—
	386	Grey copper	Chacabuco	—	—
	387	Argentiferous lead	—	Q. del Toro	—
	388	Chalcopyrite, hæmatite, silicate of copper	—	—	—
	389	Cuprite and hæmatite	—	—	—
	390	Chalcopyrite, argentiferous lead, ferruginous quartz	La Estrella	—	—
	391	Argentiferous lead, ochre	Bernardina	—	—
	392	Grey copper	Chacabuco	—	—
	393	« » blue carbonate	Concordia	S. Antonio de los Cobres	—
	394	Argentiferous lead	—		—
	395	Chrysocolla, chalybite	4 de Octubre	—	—
	396	Tetrahedrite, chalkosine	Chacabuco	—	—
	397	Malachite, chalkosine, grey copper quartz	Concordia	—	—
	398	Cerussite, argentiferous lead, quartz	—	—	—
	399	Silicate of copper and iron	—	—	—
	400	Chalkosine	San Miguel	—	—
	401	Grey copper, galena	Concordia	—	—
	402	Tetrahedrite, chalkosine	Chacabuco	—	—
	403	» »	—	—	—
	404	Grey copper, chalkosine	Concordia	—	—
	405	Tetrahedrite	Chacabuco	—	—
	406	Galena, melaconite	El Delirio	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	407	Galena, grey copper	Concordia	S. Antonio de los Cobres	Salta
	408	Green carbonate, melaconite, ochre.	-		—
	409	Silicate of copper and iron	San Juan	—	—
	410	Galena, chalkosine	Concordia	—	—
	411	Tetrahedrite	Chacabuco	—	—
	412	Blue and green carbonates of copper, ochre	Concordia	—	—
	413	Galena, blue and green carbonates of copper, ochre	—	—	—
	414	Chrysocolla, iron	4 de Octubre	—	—
	415	Machite, iron	Milagro	—	—
	416	Chrysocolla, iron	4 de Octubre	—	—
	417	Malachite, cerussite, ochre	—	—	—
	418	Silicate of copper	—	—	—
	419	» » » and iron	Sto. Dom'go	—	—
	420	Galena, grey copper	Concordia	—	—
	421	» hæmatite, ochre	—	—	—
	422	Hæmatite, cerussite	—	—	—
	423	» ochre	—	—	—
	424	Tetrahedrite	Chacabuco	—	—
	425	»	—	—	—
15	426	Grey copper, argentiferous lead	Concordia	—	—
	427	» » » »	—	—	—
	428	» » » »	—	—	—
	429	» » » »	—	—	—
	430	Galena, grey copper, pyrites containing gold	—	—	—
	431	Galena, grey copper	—	—	—
	432	» » »	—	—	—
	433	Grey copper	Chacabuco	—	—
	434	»	—	—	—
	435	» »	- -	—	—
16	436	Galena, chalcopyrite, malachite, red ochre, cerussite	«Esperanza»	Uspallata	Mendoza
	437	Galena, pyrites, siderite	Florida	—	—
	438	Chalcopyrite, ochre	—	—	—
	439	Galena, blende, siderite	—	—	—
	440	» » »	—	—	—
	441	» fluor spar	—	—	—
	442	» iron, ochre	—	—	—
	443	» cerussite	S. Francisco	—	—
	444	» carbonate of iron	—	—	—
	445	» blende, siderite, chalcopyrite	—	—	—
	446	» hæmatite, cerussite	—	—	—
	447	Phillipsite, chalcopyrite	—	—	—
	448	Galena, blende, siderite	—	—	—
	449	» siderite, lime.	—		—
	450	Galena	—	—	—
	451	Galena, siderite, lime.	—	—	—
	452	» » chalcopyrite	—	—	—
	453	» » »	—	—	—
	454	Fine grained galena	—	—	—
	455	Galena, iron	—	—	—
	456	» hæmatite	—	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	457	Galena siderite.	S. Francisco	Uspallata	Mendoza
	458	» »	—	—	—
	459	» »	VetaVillegas	—	—
	460	» »	—	—	—
	461	» » blende	—	—	—
	462	» »	Rosarito	—	—
	463	» »	—	—	—
	464	» » chalcopyrite	—	—	—
17	465	Coal	—	San Rafael	—
	466	»	—	—	—
	467	»	—	—	—
18	468	Argentiferous lead	—	Fierro	San Juan
	469	» »	Felicidad	—	—
	470	» »	Muy Escaso	—	—
	471	Black blende.	Encantadora	Tontal	—
	472	Galena, cerussite, ochre	Celia	-	—
	473	» » blende.	Sanjuanina	CastañoViej	—
	474	» » cerussite	Sto. Dom'go	Salado	—
	476	Galena piritosa	Isaura	—	—
	477	» ochre	—	—	—
	478	» »	—	—	—
	479	» »	—	—	—
	480	» malachite, blende, ochre. . . .	—	Fierro	—
	481	» iron	—	—	—
	482	» cerussite, ochre	—	—	—
	483	» » quartz, ochre	—	—	—
	484	Galena, cerussite	Carrachas	—	—
	485	» malachite, quartz	Delicias	—	—
	486	Carbonate and silicate of copper	—	—	—
	487	Malachite, chrysocolla, quartz. . . .	R. Cruz	—	—
	488	Chrysocolla, hæmatite, quartz	Rincón	—	—
	489	Chalcopyrite, green carbonate.	—	—	—
	490	Malachite, calcite	Puntilla	—	—
	491	Chrysocolla, hæmatite, quartz. . . .	Calagulla	—	—
	492	Malachite, chalcosine, iron	—	—	—
	493	Malachite, cuprite, chrysocolla, limonite .	Bicolor	—	—
	494	Silicate of copper and iron	C. de la Brea	—	—
	495	Malachite, limonite, ochre, quartz . . .	—	—	—
	496	Bornite, crysocolla, hæmatite, quatz. . .	—	—	—
	497	Chrysocolla, hæmatite	—	—	—
	498	» »	—	—	—
	499	Malachite, chalkosine, grey copper, hæmatite	Fierro	—	—
	500	Auriferous quartz, ochre	Describidora	—	—
	501	» » »	—	—	—
	502	Auriferous quartz, galena, ochre	José Cabello	Piomanta	—
	503	» » » »	—	—	—
	504	» »	Lentazon	Fierro	—
	505	Malachite, limonite, with gold	Pizarro	—	—
	506	Auriferous ferruginous quartz, ochre . .	Cruz	—	—
	507	» » » » . .	No me engañes	—	—
	508	» » » » . .	Gualilan	Gualilan	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	509	Auriferous quartz	Carmen	Tontal	San Juan
	510	» » chalcopyrite ochre	Pardo	Fierro	—
	511	Pyrites, blende, quartz	—	—	—
19	512	Galena, pyrites	Argentina	Guachi	—
	513	» » blende	Sto. Dom'go	Salado	—
	514	Chrysocolla, chalkosine, hæmatite	Vicuñitas	—	—
	515	Cuprite, malachite, hæmatite	Alista	Mondaca	—
	516	Galena, pyromorphite, cerussite	—	Fierro	—
	517	» » » malachite	Dios proteja	CastañoViej.	—
	518	Cerussite, galena, iron	—	—	—
	519	Chalcopyrite, blende, iron	Blanca	Huerta	—
	520	» chysocolla, galena	—	—	—
	521	Hæmatite, chrysocolla	Angelita	—	—
	522	Auriferous quartz	Andacolla	—	—
	523	Limonite, chrysocolla, quartz	—	—	—
	524	Galena, cerussite	Venus	Fierro	—
	525	Malachite, cuprite, iron	Rojas	Chita	—
	526	Green and blue carbonates of copper galena, cerussite	—	—	—
	527	Chalcopyrite, blende, iron	P. del Norte	Gualilan	—
	528	Grey copper, blue carbonate, baryte	—	Iglesia	—
	529	Argentiferous lead	—	CastañoViej.	—
	530	» »	—	Iglesia	—
	531	» » limonite	San Juan	—	—
	532	Pyrite of iron, blende	Magnata	Gualilan	—
	533	» » » galena, quartz	—	—	—
	534	Argentiferous lead, chalcopyrite, marcasite	—	—	—
	535	Auriferous ferruginous quartz	Magnata	Gualilan	San Juan
	536	Galena, grey copper, malachite	—	—	—
	537	Pyrite of iron, blende, ochre, quartz	—	—	—
	538	Auriferous ferruginous quartz	—	—	—
	539	» » »	—	—	—
	540	» » » malachite, ochre	—	—	—
	541	Argentiferous lead	Felicidad	—	—
	542	» » malachite, iron	Rosarito	—	—
	543	Auriferous ochre	—	Iglesia	—
	544	Argentiferous lead, malachite, lime, quartz	La Estrella	CastañoViej.	—
	545	Auriferous iron ore	Felicidad	—	—
	546	Silicate of copper	—	—	—
	547	Chalcopyrite, quartz	—	—	—
	548	Bornite, pyrite, quartz	—	—	—
	549	Chalcopyrite	—	—	—
	550	Chrysocolla, melaconite	—	—	—
	551	Argentiferous lead	—	—	—
	552	» »	—	—	—
	553	Chrysocolla, quartz	—	—	—
	554	Argentiferous lead	—	—	—
	556	» »	—	—	—
	557	Chrysocolla, ochre, quartz	—	—	—
	558	Galena, antimony	Loca	—	—
	559	Chalcopyrite	—	—	—
20	560	Galena, antimony	—	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	561	Galena, green and blue carbonate of copper	—	—	—
	562	Galena, quartz	—	—	—
	563	Antimony, quartz	SanJeronimo	—	—
	564	» »	—	—	—
	565	Limonite	—	—	—
	566	Blue and green carbonates of copper	Chorilla	—	—
	567	Angentiferous lead, antimony	Carmen	Tontal	—
	568	Malachite, iron, quartz.	—	—	—
	569	Ferruginous auriferous quartz	—	Gualilan	—
	570	Argentiferous lead, antimony.	Carmen Alto	Tontal	—
	571	Malachite, chrysocolla, quartz	—	—	—
	572	Cuprite, and carbonate of copper	—	—	—
	573	Argentiferous iron ore, galena	—	—	—
	574	Galena, blende, chalcopyrite.	—	—	—
	575	Auriferous quartz	—	Gualilan	—
	576	Argentiferous lead, cerussite	—	—	—
	577	Auriferous quartz, ochre	—	—	—
	578	Pyrite of iron (auriferous).	—	—	—
	579	Auriferous quartz, ochre	—	—	—
	580	Chrysocolla and oxide of copper	—	—	—
	581	Galena, ochre, quartz	—	—	—
	582	»	—	—	—
	583	»	—	—	—
	584	» ochre	—	—	—
	585	Grey copper, carbonates, limonite	—	—	—
	586	Malachite, ochre	—	—	—
	587	Argentiferous lead, antimony	Carmen Alto	Gualilan	San Juan
	588	Green carbonate of copper, iron.	—	—	—
	589	Galena, cerussite	—	—	—
	590	» limonite, quartz	—	—	—
	591	» » »	—	—	—
	592	» » »	—	—	—
	593	» » »	—	—	—
	594	» » »	—	—	—
	595	» » »	—	—	—
	596	» » »	—	—	—
	597	Grey copper, pyrites quartz	—	—	—
	598	Chrysocolla, limonite	—	—	—
	599	» »	—	—	—
	600	»	—	—	—
	601	»	—	—	—
	602	Auriferous ferruginous quartz	—	Gualilan	—
	603	—	—	—	—
	604	Pyroulisite	—	—	San Luis
	605	Chrysocolla, malachite, hæmatite	—	—	—
	606	Manganese ore	—	—	—
	607	»	—	—	—
	608	Chrysocolla, hæmatite, quartz	—	—	—
	609	Manganese ore	—	—	—
	610	Argentiferous lead, limonite	—	Carolina	—
	611	Aurifeous schist, pyrites of iron, etc.	—	—	—
	612	Argentiferous lead, blende	—	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	613	Auriferous schist. pyrites of iron.	—	—	—
	614	Malachite, limonite.	—	—	—
21	615	Auriferous schist, pyrite.	—	—	—
	616	Chrisocolla, quartz.	—	—	—
	617	Carbonate of copper, limonite, quartz	—	Carolina	—
	618	Auriferous schist, pyrite	—	—	—
	619	Chrysocolla, limonite, quartz.	—	—	—
	620	» hæmatite.	—	—	—
	621	» quartz	—	—	—
	622	Malachite, limonite.	Bella Vista	—	—
	623	Hæmatite chrysocolla	—	—	—
	624	Carbonate of copper, limonite	—	—	—
	625	Phillipsite, Chalcopyrite, chrysocolla	—	—	—
	626	Chrysocolla, hæmatite.	Angelita	—	—
	627	Hæmatite, cerussite.	—	—	—
	628	» chrysocolla.	Abra	—	—
	629	Chalcopyrite, hæmatite, quartz	—	—	—
	630	Phillipsite, chrysocolla, quartz	—	—	—
	631	Cerussite, quaatz, limonite	Piedra Balas	—	—
	632	Galena, limonite	—	—	—
	633	» cerussite, iron	—	—	—
	634	»	—	—	—
	635	Phillipsite, baryta	—	—	—
22	636	Auriferous pyrites of iron.	—	—	Jujuy
	637	» » »	—	—	—
	638	Cuprite, carbonate of copper, chrysocolla.	—	—	—
	639	Carbonates of lead and copper	—	—	—
	640	Grey copper, pyrites	Piedra Balas	Carolina	Jujuy
	641	" " , chalkosine	—	—	—
	642	Bornite, covelline, chalcopyrite.	—	—	—
	643	Pyrite of iron, blende, quartz	—	—	—
	644	Pyrolusite	—	—	—
	645	Phillipsite, carbonate of copper, chrysocolla	—	—	—
	646	Sulphide of silver, blende, iron	—	—	—
	647	Cuprite, chrysocolla, oxide of iron.	—	—	—
	648	Antimony.	—	—	—
	649	Azurite, malachite	—	—	—
	650	» quartz	—	—	—
	651	Green and blue carbonate of copper	—	—	—
	652	Grey copper, chrisocolle	—	—	—
	653	Green and blue carbonates of copper	—	—	—
	654	Carbonate and silicate of copper, iron.	—	—	—
	655	Blue and green carbonate, iron	—	—	—
	656	Grey copper.	—	—	—
	657	Chalcopyrite, melaconita	—	—	—
	658	Bornite, covalline, chalcopyrite	—	—	—
	659	Grey copper, chalcopyrite	—	—	—
	660	Auriferous ferruginous quartz, blende	—	—	—
	661	Pyrite of iron	—	—	—
	662	Green carbonate, melaconite.	—	—	—
	663	Cuprite, green carbonate of copper.	—	—	—
	664	Chalcopyrite, limonite.	—	—	—
	665	» »	—	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	666	Argentiferous lead	—	—	—
	667	Green and blue carbonates of copper quartz	—	—	—
					National Territory of
23	668	Bituminous coal	—	Lago	Neuquen
	669	» »	—	Nahal Huapi	—
	670	» »	—	—	—
					Province
24	671	» friable coal	—	San Rafael	Mendoza
	672	» » »	—	—	—
25	673	» » »	—	—	—
					National Territory
	674	Lignite	—	Sloggett Bay	T. del Fuego
	675	»	—	—	—
	676	»	—	—	—
	677	»	—	—	—
					Province
	678	»	—	—	Salta
	679	Poor bituminous coal	—	Himanas	San Juan
26	680	Briquettes made froom small bituminous coal	—	San Rafael	Mendoza
	681	» » »	—	—	—
	682	Briquettes made froom small bituminous coal	Piedra Balas	San Rafael	Mendoza
	683	» » »	—	—	—
	684	» » »	—	—	—
					Territory of
27	685	Hydro borate of lime	—	Caurchari	Los Andes
	686	» » »	—	—	—
28	687	» » » (These samples obtained for excellent quality the heighest award at the Exhibition of Chicago in 1893)	—	—	—
29	688	Marble	—	—	Mendoza
	689	»	—	—	—
	690	White marble	—	—	Salta
	691	Natural refractory bricks cut out of mass.	—	Payman	Rioja
	692	» » »	—	—	—
	693	Variegated marble	—	—	—
30	694	Block salt (each line represents one years deposition	—	—	Salta
					Territory
31	695	Silicate of copper, oligistic iron	—	Lihuel Calel	Pa. Central
	696	» »	—	—	—

Number of Box	Number of Sample	CLASSIFICATION	Mine	District	Province
	697	Silicate of copper, oligistic iron. . . .	—	—	—
					Province
	698	Antimony, quartz	—	Chumbicha	Catamarca
	699	Pyrite of iron	Rosario	Capillitas	—
	700	Titaniferous iron ore	Romay	Romay	—
	701	Antimony.	Mejicana	Andalgala	—
	702	» quartz	—	—	—
	703	» »	—	—	—
	704	Asbestus	—	—	San Juan
32	705	Melaconite	Grande	Capillitas	Catamarca
	706	Carbonate and oxide of copper, limonite, ochre	Santa Clara	—	—
					Territory
	707	Silicate of copper, oligistic iron. . . .	—	Lihuel Calel	Pa. Centra
					Province
	708	Argentiferous lead.	Sta. Barbara	—	Cordoba
	709	» »	—	—	—
	710	» »	—	—	—
	711	» »	—	—	—
	712	» »	—	—	—
	713	» »	—	—	—
	714	» »	—	—	—
	715	» »	—	—	—
	716	Sulphur	—	Zonda	San Juan
	717	Sulphur	Sta. Barbara	Zonda	San Juan
	718	"	—	—	—
33	719	Natural salt		—	Salta
	720	Asbestus	Negra	—	San Luis
	721	Enargite sulphate of copper	—	Los Bayos	La Rioja
	722	» » and pyrite.	—	—	—
					Territory of
	723	Native copper	—	—	Misiones
	724	» »	—	—	—
	725	» »	—	—	—
	726	» »	—	—	—

The Famatina Development Corporation (Limited)

Province of La Rioja

This Company has previously been referred to in this work, and some account of its proceedings given; but, at the last moment, the writer received the following table of data from one of the Chief Directors, now in Buenos Aires.

MINES	Kilos of ore smelted	AVERAGE ASSAY.			CONTENTS IN KILOS.		
		Copper.	Silver.	Gold.	Copper.	Silver.	Gold.
		%	%	%			
Upulungos	150127	4·52	0·498	0·0161	6797	74·768	2·431
Jesús María	6261	12·10	0·056	0·0091	758	0·351	0·058
Andueza	117273	3·95	2·798	0·0178	4633	328·079	2·097
San Pedro	353570	12·42	0·088	0·0130	51010	31·279	4·621
Compañía	108539	5·52	0·555	0·0112	5994	60·253	1·220
White lode	156718	3·13	0·638	0·0304	4916	99·996	4·769
Ophir	15792	6·49	0·289	0·0090	1025	4·563	0.143
Total	908280	8·30	0·660	0·0169	75133	599·286	15·338
MINERAL PURCHASED							
Humango	1998	39·53	1·389	—	790	2·771	—
Silver. Ore	730	—	10·033	—	—	77·324	—
	911008	8·33	0·668	0·0169	75923	609·387	15·338
Allowance for loss in Smelting	—	6 %	10 %	5 %	4555	60·938	0·766
Total to be produced	—	—	—	—	71368	548·449	14·572
Shewn in matte produced	—	—	—	—	73989	568·594	15·082

Chilecito, 24th April 1904.

It will be seen that a total of 908·280 kilos of copper mineral were obtained from six of the large and important group of mines in the Mejicana district, and possessed by this Company. The assay and metal produced are also included. The quantities have not been re-calculated, it being preferred to give the data in the original form, as received.

It appears from the above table that the best copper mineral containing silver and gold, was obtained from the "*San Pedro*" and "*Jesús María*" mines, the ore yielding at the rate of

14·10 % of copper, 0·088 % of silver, and 0.0130 % of gold, and the other 12·10 % of copper, 0·058 % of silver and 0·0091 % of gold. This class of mineral is, consequently, of a good quality for smelting.

The White Lode has, according to the above data, yielded the greatest amount of gold, i. e., at the rate of 0·0304 %: all the mines mentioned, however, produce a considerable amount of gold.

It appears that the Development Corporation, limited, is opening up their mines, as previously indicated, for the object of proving their productive qualities, so that the quantity of copper ore as given in the above table can only be considered as a trial sample. However, when the body of the ore existing in the mineral veins, now being opened up is extracted, a large and constant supply of ore may be expected, and it is only reasonable to infer that the general yield of metal will exceed that now exhibited in the table.

For example, when the poorer zone in the Upulungos Mine has been passed, and its influence on the quality of the ore ceased, the copper ore from that mine should be as rich as it was before the poorer zone was encountered.

Naturally, at certain undefined depths poorer zones of ore may occur in the other mines, but this could only influence the quality and yield of the ore occurring in such zones; which, however, are of a limited extent.

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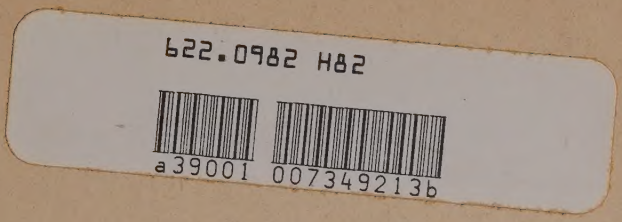

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